WORLD PETROLEUM

NEW YORK AND LONDON

MARCH 1938

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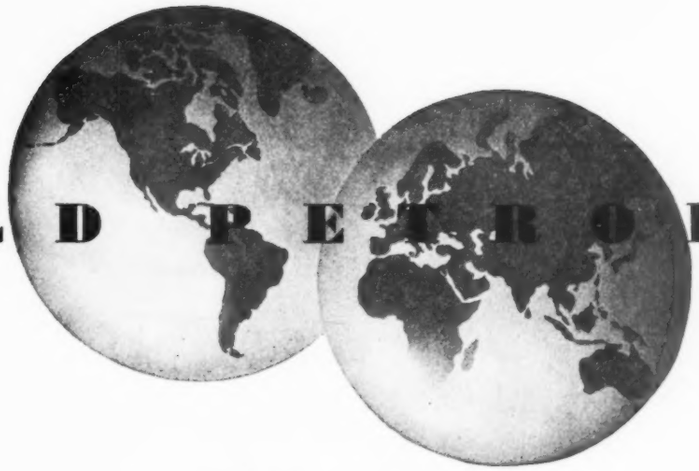

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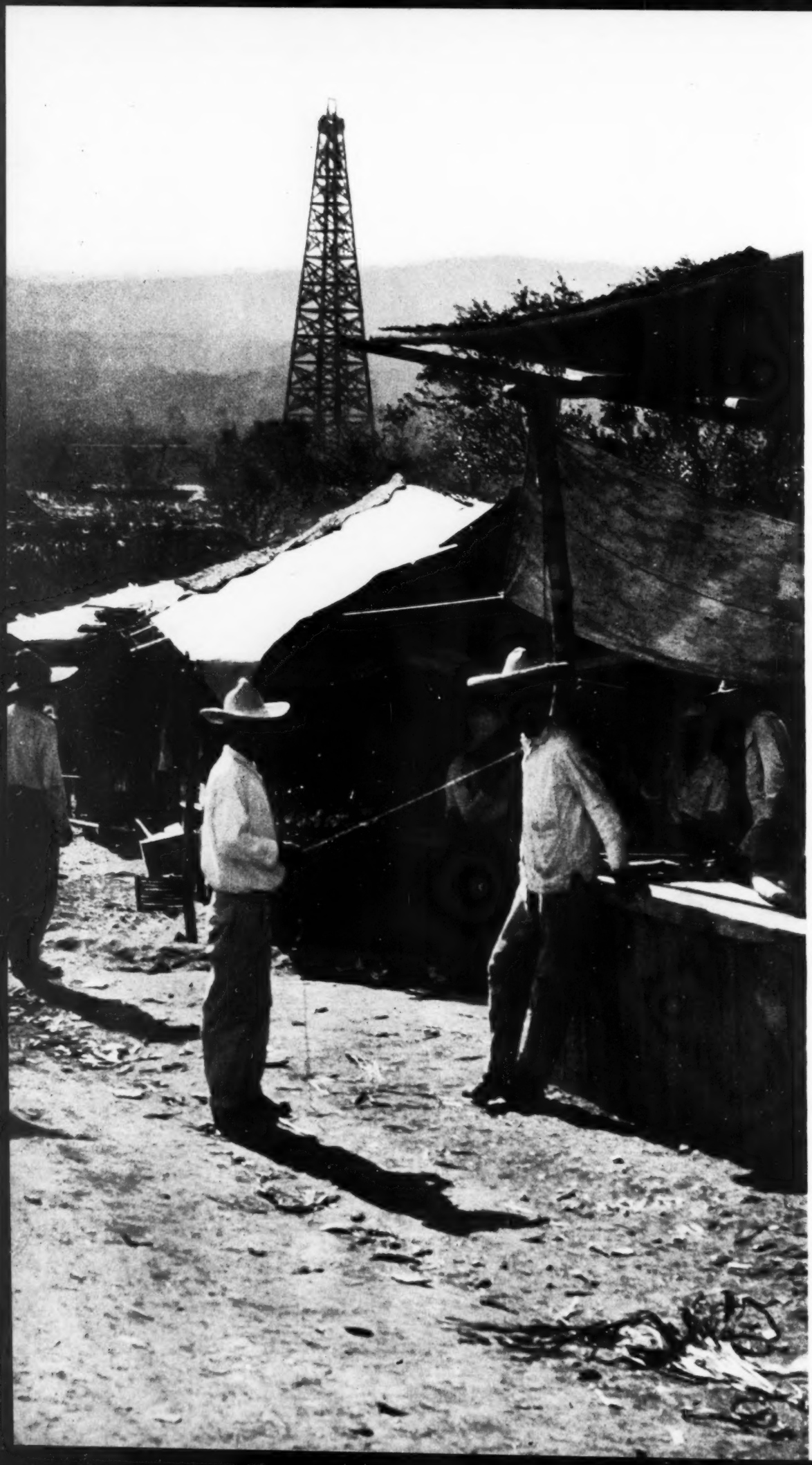


A market street scene in the Mexican oil town of Zacamixtle.

Burton Holmes from Ewing Galloway

TREND OF WORLD PRODUCTION

STATISTICS of petroleum for the year 1937 reveal some interesting trends in production which are likely to assume added significance in the future. These trends become more clearly marked if one looks back over the past five years and takes note of the changes that have occurred during that period. Such a comparison indicates that important shifts are taking place in the relative position of a number of oil producing and exporting areas. Certain countries that have been leading factors in international trade throughout the history of the industry are becoming less influential in this respect while new territories are rising to a place of primary importance in supplying the world's ever-increasing demands for petroleum and its products.

While these changes are taking place it is interesting to note, however, that the United States retains practically the same relative position that it has long held in the world petroleum picture. In 1937 it produced 62.5 percent of the total oil supply or approximately the same percentage as thirty years ago. In fifteen years its proportion of the total output has declined from 72 percent to the present figure but since 1930 its position has remained relatively stable. With the intensification of the search for oil in other parts of the world the proportionate share of production contributed by the United States may be expected to decrease gradually though little relative change in this respect is to be anticipated immediately.

The most noteworthy change that has taken place in the past five years has been the rise to importance of the Near East. In 1932 the output of oil in the countries of southwestern Asia was roundly 50,000,000 bbl. In 1937 it was over 117,000,000 bbl., an increase of 132 percent. In the intervening period production in Iran almost doubled, Iraq has risen to sixth place among the oil-producing nations and a new-comer, Bahrein, has been making vast strides in output which indicate that it presently will take its place among the dozen top producers.

While the present production of these countries is still less than that of Russia or Venezuela the progress that has been made in the past few years seems certain to continue and probably to be accelerated in the immediate future. Iraq's output at present is limited by the capacity of the pipelines leading to the Mediterranean but structures have been uncovered capable of doubling its production as soon as the problems of treating and transportation are solved. Bahrein is only well started on its career as a producer while in all the surrounding territories, including Saudi Arabia, the areas along the Red Sea, the Trucial Coast, in Syria, the undeveloped portions of Iran and all of Afghanistan active exploration is under way which may, and probably will, bring in production equal to or possibly exceeding that which thus far has been attained. In any survey of the future, the Near and Middle East must be counted on as one of the most important factors in international oil trade, the more so as local demand in this area is small and the greater part of its output can go to satisfy the requirements of the principal consuming countries.

In the Far East likewise great potentialities exist. In the past five years the Netherlands East Indies have increased production 42 percent and the very extensive campaign of exploration now being carried out in Sumatra and New Guinea may result in greatly increasing the production of this quarter of the globe.

One other section in which there is positive assurance of a large expansion of production during the next few years is the northern part of South America, specifically Venezuela and Colombia. Venezuela's outturn has increased by 62,000,000 bbl. or 57 percent in the past five years and in 1937

the gain over the preceding year was just over 20 percent. The active drilling campaign which has been under way for the past year and which is being continued probably will place Venezuela second only to the United States among world producers within the coming year. In Colombia completion of the pipeline from the Barco field, together with other development work under way, probably will double that country's output by 1940.

Within the next three years, therefore, much of the development activity in petroleum and much of the world's interest will be centered in the three areas referred to above and many important changes may be looked for on the map of the international oil trade.

FEDERAL PURSUIT OF THE OIL INDUSTRY

During 1935 and 1936 the price of petroleum and its products increased in all parts of the world in response to an exceptionally rapid rise in demand. According to the claim put forward by representatives of the Department of Justice of the United States and confirmed by the decision of a jury in the recent trial at Madison, Wisconsin, however, the advance which took place in that particular area was due solely to manipulation by sixteen oil companies and thirty individuals, officers of those companies.

The court in which the trial took place naturally was not concerned with developments beyond its jurisdiction. Consequently the striking coincidence of a price increment in every part of the globe simultaneously with the upward movement in the United States, allegedly due to conspiracy by the accused, did not come up for judicial consideration. Had it been necessary, however, the prosecutors no doubt would have been prepared to claim that higher prices in Constanza, Cape Town, and Sydney were due to the relatively minute purchases of the indicted oil companies in one section of Texas.

Flushed by its success at Madison, the Department of Justice has been looking into other possible lines of attack upon the industry in the Mid-West, the East and on the Pacific Coast. Recently it has turned its attention to Texas and is reported to be conducting an investigation there in the hope of being able to prosecute another conspiracy—this one to maintain crude prices.

The complaint of the East Texas refineries is that the margin between the price levels of crude oil and gasoline is insufficient to permit them to operate without loss. Since the federal prosecutors have conducted a long trial to prove that gasoline prices are excessive the only logical position they can take in following up an allegation of this sort is that crude prices likewise are too high.

The reported effort of the federal government to find a basis for attack on the crude price structure assumes special significance when it is considered that a fair level of crude prices heretofore has been regarded as the very foundation of stability in the oil industry. One of the first acts of the Roosevelt administration, even before the creation of the National Recovery Administration, was to call a conference in Washington to consider ways and means of remedying the demoralization of crude oil prices that existed in the early months of 1933.

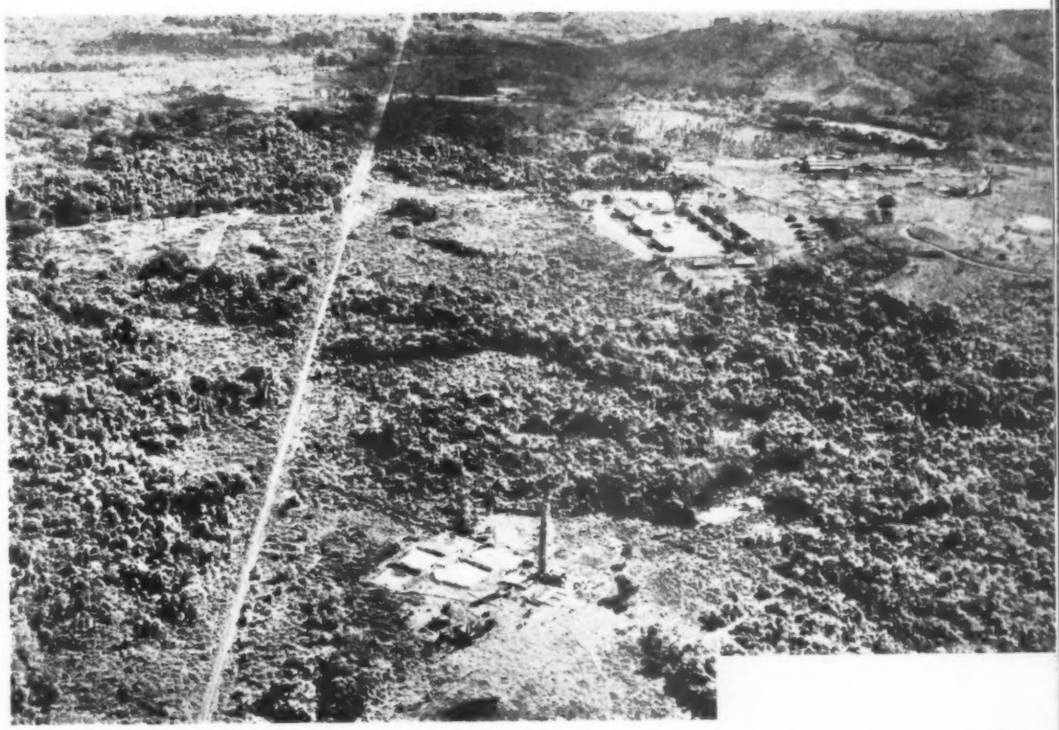
When the National Petroleum Administration was brought into existence its first effort was to end the physical waste and economic damage caused by the low price of crude then prevailing. Through the exercise of its authority, and with the cooperation of the oil producing states and representatives of the industry, the price was brought up from around thirty cents a barrel to a basic figure of $1.11 in East Texas. A secondary objective of the Petroleum Administration was to raise the price of gasoline to six cents per gallon in order to establish its proper economic relation to the crude price. This second part of the program was not carried to completion, but throughout the period of direct government control the crude price level was maintained.

Even after the court decision invalidating the National Industrial Recovery Act the members of the oil industry were urged by official spokesmen not to allow the crude price structure to be upset. It was pointed out that if this price level were broken it would plunge the industry into the chaos and destruction from which it had so recently emerged.

A reversal of the administration's former policy of seeking to promote stabilization in the oil industry is more difficult to understand in the case of crude oil than in the case of refined products which was dealt with at Madison. Demoralization of the crude oil market would spread loss and destruction among thousands of small independent operators, would lessen the income of tens of thousands of royalty owners and would strike a damaging blow at the economic welfare of the oil producing states. It is difficult to believe that the oil industry is being subjected to repeated attacks because it has demonstrated its ability to conduct its operations without the crutch of federal regulation to lean upon, but the only other explanation that seems to fit the situation is the will to the exercise of power and punishment which seems to be irresistible among the practitioners of personal government.

MEXICO'S SOCIALIZATION Program Imperiled by Demands of Privileged Oil Workers

Economic Interests of Country Point to Need of Fair Treatment of Interests Providing Large Revenues but Domination by National Revolutionary Party Forces Companies to Withdraw.



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Air view of Mexico's most important oil producing area—Poza Rica.

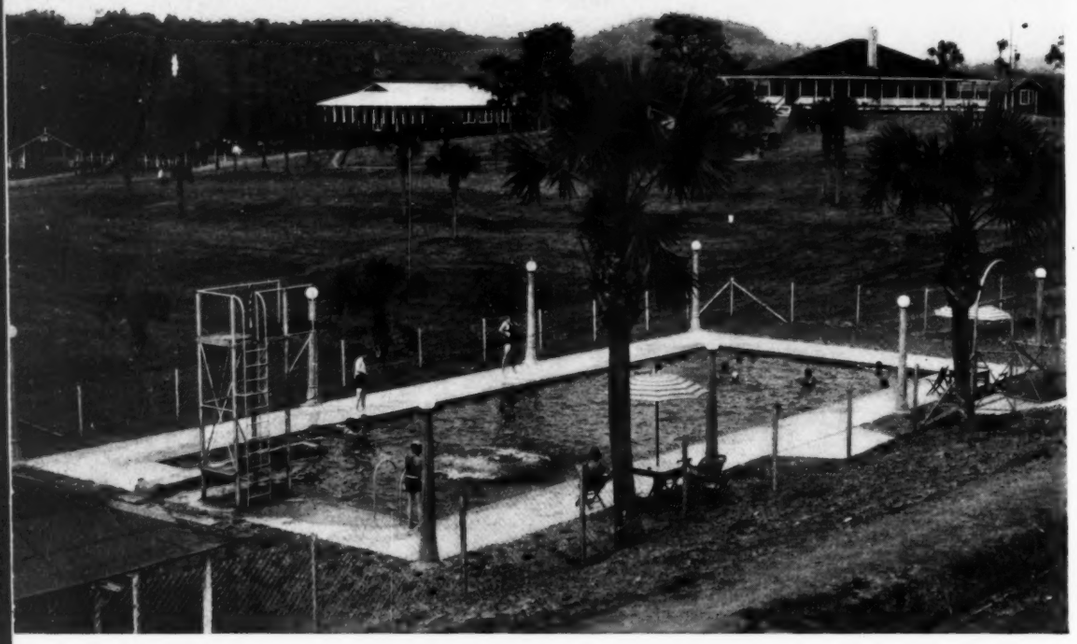
THE crisis which has long been threatening the oil industry of Mexico has arrived. It presented itself with the decision of the Mexican Supreme Court on March 1, upholding the finding of the federal labor board, which in turn supported the demands of the unions of oil workers for greatly increased wages and other special concessions.

The action of the court did not come as a surprise. Vicente Lombardo Toledano, head of the workers federation, had announced a week before that its decision would be adverse to the oil companies. President Cardenas at the same time denounced the companies as being responsible for the economic crisis of the country while the press of the National Revolutionary party had carried on a systematic campaign of denunciation against them for months preceding.

By casting his lot with the powerful labor federation the President apparently has committed himself to continuing support of the union's program by seizing the property of the oil companies, if necessary, and handing its operation over to the workers. At the same time he runs the risk of seriously crippling his plans for socialization of the land and the agricultural industries of the country. The execution of these plans requires very large expenditures and it is no secret that the Mexican government is desperately in need of funds. The international oil companies have been among the country's largest providers of revenue and have paid upward of $250,000,000 to the government in taxes. It is improbable that the government, by turning the oil properties over to operation by the workers, can obtain anything like the amount of revenue it was able to derive from the companies through taxation.

Another angle of the situation, though probably not of immediate concern, may be productive of trouble for the government in the future. The oil workers constitute a small though highly favored class in Mexico. There are only 18,000 of them, a fraction of the total industrial army and a small number compared even with the 53,000 miners. But the oil workers receive wages several times those of the average industrial employe, besides special advantages in the way of vacations with pay, free housing and medical treatment and other emoluments not shared by the average worker. If the Cardenas administration finds itself in a position where it is unable to continue the payments which it has been making to the members of the agricultural colonies it has established, discontent may develop among the agrarian population. If the price of motor fuel rises and the quality deteriorates, as is very likely to happen under a soviet form of refinery operation, other groups will be disaffected. Workers in other lines of industry may resent the special favors extended to oil workers when it no longer can be said that these are provided at the expense of foreign capitalists.

Producing well and transportation facilities in the Poza Rica field, which has been crippled frequently by strikes of oilfield workers.



Careful provision is made by oil companies operating in Mexico for the health and recreation of their employees.

These are only possibilities but many observers of conditions in Mexico agree that if the flow of funds to the farm cooperatives and other pet projects of the President is stopped, trouble will result. Trouble in Mexico usually takes the form of demonstrations against the government. So long as he has the united support of the army no Mexican President need be greatly worried, but the army itself may be more sympathetic to the agricultural class from which it is recruited than to the labor unions if a choice becomes necessary.

While the government had not actually taken charge of the oil properties up to March 12 and seemed reluctant to do so the last possibility of a compromise between the companies and the workers has become very doubtful with the publication of the court's decision. With the seal of official approval which they now have received the unions are in no mood to abate their demands. Oil company officials declare that compliance with the award would increase their operating cost by some $15,000,000 yearly. As their total net income in their best year of operation was only $6,600,000 the comparison of these two sums gives a concise picture of the situation as it presents itself to the companies.

Early in the present struggle the oil companies offered wage increases amounting to 7,000,000 pesos, but the offer was rejected. At that time this sum was put forward as the maximum that the companies could pay and still maintain their operations in Mexico. Following the announcement of the supreme court decision, the companies issued the following statement reiterating their position:

"The undersigned petroleum companies have heard that the Supreme Court at a public session denied the appeal for an injunction against the judgment recently handed down by the Federal Labor Board in connection with the economic conflict between the companies and the Petroleum Syndicate.

"The companies have made it abundantly clear during the past months to their employes and to the general public that the conditions recommended by the commission of experts that served as the basis of the Labor Board decision are of such a nature that it would be impossible to comply with them. Their inability to comply remains unaltered by today's verdict.

"Accordingly, they regret deeply the decision of the Fourth Section of the Supreme Court on their appeal for a permanent injunction, which cannot but have serious consequences for the companies, for their employes and for those dependent on the industry."

The above statement was signed by the Mexican Eagle Oil Company, Huasteca Petroleum Company, Sinclair Pierce Oil Company, Mexican Sinclair Petroleum Corporation, Standard Oil Company of Mexico and its operating subsidiary, Richmond Petroleum Company, these being the principal international companies in Mexico.

While the pronouncement of the oil companies does not specifically proclaim their intention to withdraw from Mexico the statement that they cannot comply with the decision is tantamount to such notice as the government obviously must act to uphold the finding of its own tribunal. The companies, of course, cannot prevent the government from seizing the properties, but in that case, their tankers naturally will not be available for transportation of the oil to foreign markets and the country's export trade in petroleum is likely to suffer. For compensation for loss of their investments amounting to upward of $400,000,000 the companies will have to depend upon representations by their respective governments.

So far as concerns the government of the United States, at least, this possibility is not regarded seriously in Mexico. Up until the beginning of the year the Washington government possessed a very effective instrument for enforcing respect for the rights of its nationals in Mexico. That was the subsidy of millions of dollars which it is paying by purchasing monthly 5,000,000 ounces of Mexican silver far above the market price. That subsidy has been one of the important props to the socialization plans of President Cardenas. When the contract was renewed early in the year without any protest on the part of Washington officials against the violation of the Morrow-Calles agreement, the confiscation of the property of Americans in Mexico without recompense and the 200 percent increase in tariff rates against United States goods the natural conclusion in Mexican official circles was that no amount of discrimination they could practice against citizens of the United States would stir the government of the latter country to defensive action. At the present time the Department of State at Washington states merely that it is "studying" the situation.

Meanwhile the Cardenas administration is exerting every effort to gather in funds and to bolster its weak financial position. Its latest move has been to conclude the sale of 1,000,000 bbl. of oil to a British syndicate. This oil will soon start moving Europeward in British tankers. While the government's production is only about 10,000 bbl. daily it is reported to have half a million barrels in storage. As the reported price of 92 to 95 cents per bbl. this transaction will bring in nearly $1,000,000. Recently the government received $4,000,000 from the sale of last season's cotton crop in the Laguna district where one of its large experiments in collective farming is being carried out.

Last year Mexico's export trade, including gold and silver sold to the United States, reached the record figure, estimated, of 828,000,000 pesos ($230,000,000). Imports also were at a high figure of 608,000,000 pesos ($169,000,000) and this was the ostensible reason for imposing temporary prohibitive tariffs on certain classes of goods. In the oil industry production reached 46,906,624 bbl. according to government estimates and this was the highest output since 1927. Petroleum exports, however, were about 1,000,000 bbl. less than in 1936 which is regarded as disappointing.

In the Poza Rica field which is now Mexico's largest single oil zone, production

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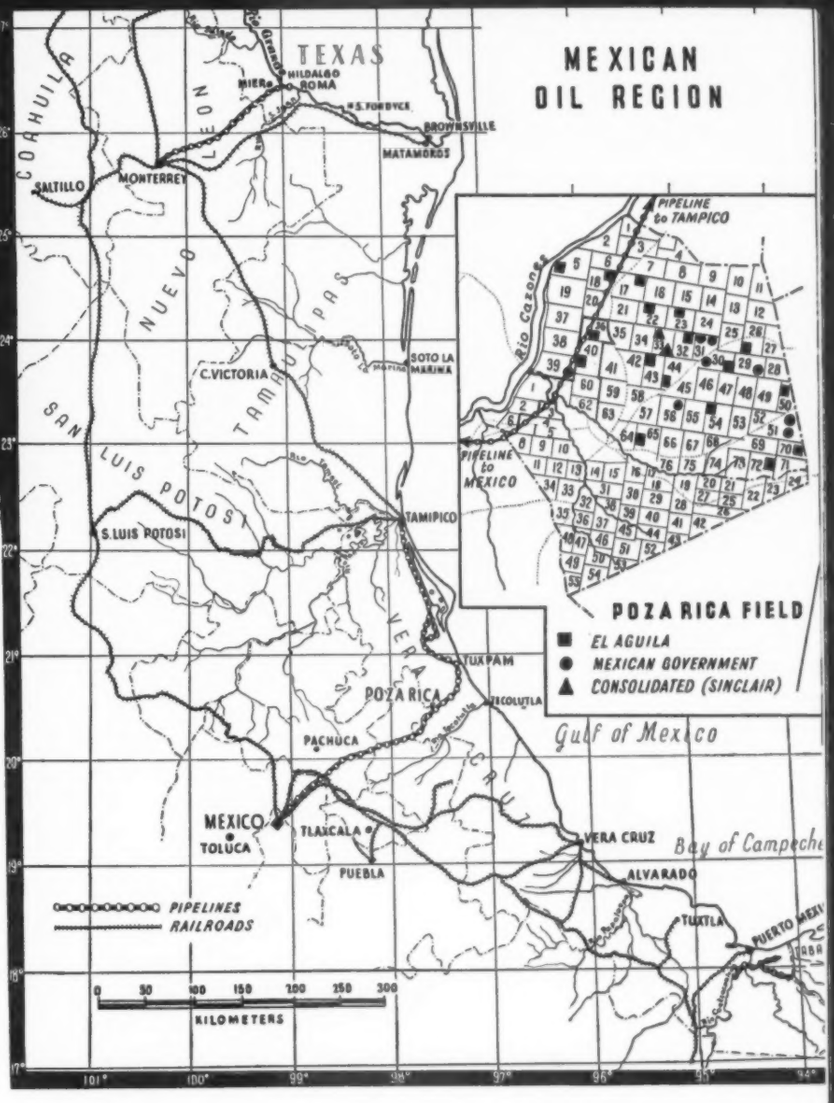
Three men whose ruling have greatly affected Mexico's oil industry—and a map of the main producing region. Members of the Mexican Supreme Court who rendered the historic decision against non-domestic oil companies. Left front: Justice Gonzales Blanco; center, reading the decision: Justice Alfredo Inarritu; right: Justice Hermilo Lopez Sanchez.



last year was 18,696,283 bbl. Next in order was the El Plan field in southern Vera Cruz, largely operated by the Mexican Eagle Oil Company, which produced 6,744,176 bbl. of light crude. These two areas, therefore, accounted for more than half the country's total output.

Until the labor controversy reached the acute stage which now virtually forces the international oil companies out of the country the policy of the Cardenas administration apparently was to enlarge its revenues by special deals with the companies for exploitation of petroleum resources in various parts of the country. One such arrangement which attracted widespread attention was made with the Mexican Eagle Oil Company (El Aguila) no longer ago than last November. This provided for the operation of the Poza Rica field, Mexico's most important single oil zone, by Aguila which was the principal holder of concessions in that area. Under this arrangement the government was to receive up to 35 percent of the oil produced. Estimates from government officials were that its income from this source might reach ultimately 150,000,000 pesos (nearly $42,000,000) yearly. Before this could be realized, however, a heavy investment would have been required as it costs an average of 250,000 pesos ($70,000) to sink a well in Poza Rica and pipeline construction costing several million pesos would have been necessary. Up to the first of this year Poza Rica's 27 wells, 17 of which belonged to Aguila and eight to the government were yielding about 70,000 bbl. daily. What effect the decision in the labor case may have on the future of this field is problematical.

Poza Rica is conceded to be Mexico's richest field. Estimates of its potentiality, by geologists, range from 2,000,000,000 to 4,000,000,000 bbl. It is easy to understand why Poza Rica has attracted world interest, in these days of increasing demand for oil. While the deal between the government and Aguila for operation of the field was announced some months ago no oil has as yet been delivered to the government under this contract.

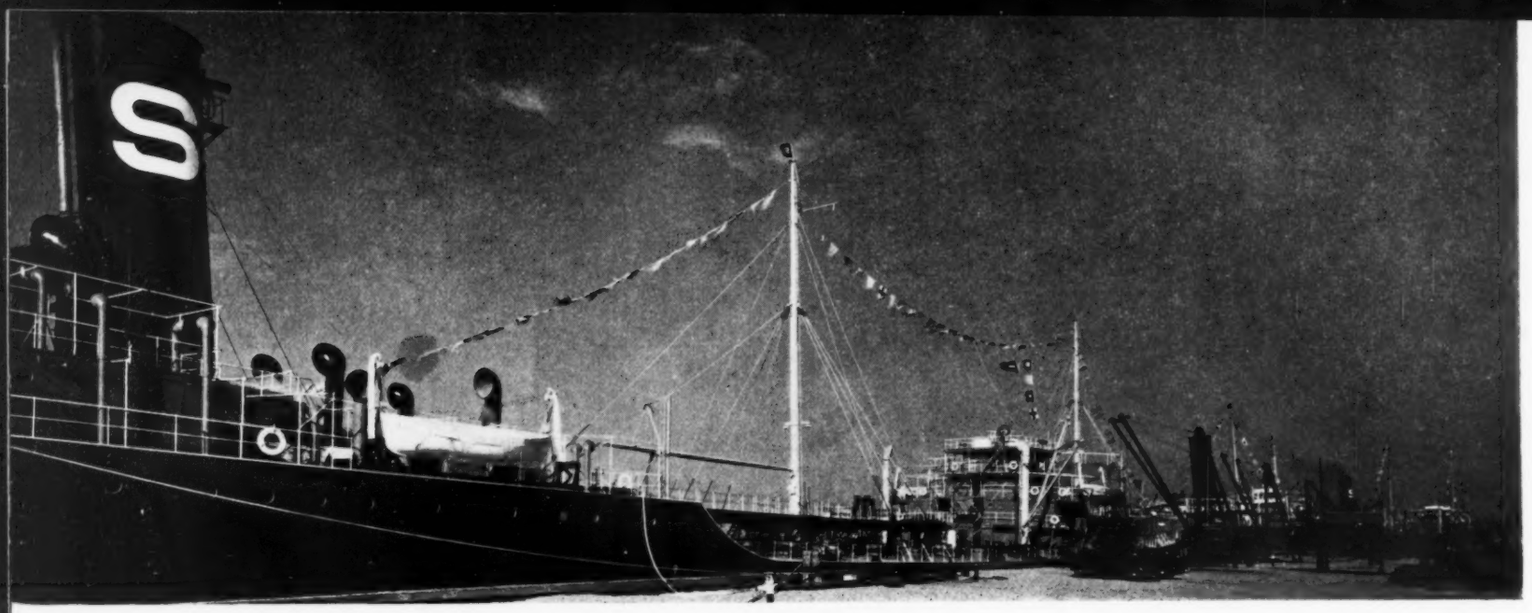
Up to February 12, Aguila had obtained from the government 62 confirmations of rights to the Poza Rica property acquired prior to enactment of the new federal constitution and the oil laws, May 1, 1917. Each of these concessions covers tracts that average about 110 acres.

As an example of the systematic attempts that have been made to stir up feeling against the oil companies may be cited an article viciously attacking Aguila for alleged neglect of its Poza Rica workers that appeared earlier in the year in the newspaper, El Nacional, organ of the National Revolutionary party which dominates the federal government. This party recently has been made an organization of workers and soldiers. The article charged that Poza Rica workers were flagrantly exploited and that while they are allowed such essentials as good beds and medicines and luxuries like telephone and radio the Aguila stinted them on a daily quota of water, some 25 liters daily.

Those who have visited the Poza Rica field realize that the workers were exceptionally well treated. Not ony did they receive high wages but the company provided them with good homes, schools and recreation grounds. But it evidently was considered good party policy to keep up the attacks on the oil companies, even those that have gone furthest in meeting the demands of the government.

While Poza Rica has loomed large in public interest of late there are other fields in Mexico, such as the Maguey belt in northern Vera Cruz in which Americans are largely interested, that were ripe for development if the government had been willing to adhere to a policy that would have permitted operation on terms fair to the companies and to itself.

It is unfortunate for the oil companies and even more unfortunate for Mexico itself that some reasonable adjustment of the labor controversy was not reached. Mexican oil production has increased substantially during the past year and the country was in a fair way to regain something of its former importance in the international oil trade. This would have meant a correspondingly large growth in its fiscal revenues and would have aided greatly in carrying out its elaborate schemes of internal development. As matters stand the development of Mexico's petroleum resources appears certain to undergo a severe setback and the whole national economy may be jeopardized by the campaign of destruction waged against the companies



Changing sources of crude oil production and greater consumption have resulted in more trans-oceanic shipments for increased distances, and the many tankers required for this purpose places the bulk oil freight market in a better position than it has been for several years.

WORLD TRADE in Petroleum During 1937

Military Requirements and Industrial Activity Have Resulted in Increased Imports in Europe and Asia—Russia and Mexico Follow Declining Trend in Exports—Near East Is Becoming Important Source of Exports.

IN CONSIDERING the movement of petroleum and products in international trade during 1937, the most striking fact in the changing sources of world supply is to be found in figures that show that only Russia, Mexico and Peru are exporting less crude and refined products now than in 1933. The United States is the only important consuming country importing less crude and refined products in 1937 than in 1933.

The majority of the important exporting countries including the United States, Venezuela, Colombia, Iraq, Bahrein and Ecuador are all exporting more of both crude and refined products; Roumania and British Borneo are exporting more crude but less refined petroleum; and Iran, Trinidad and the Netherlands West Indies shipped more refined and less crude than in previous years.

Of the large consuming countries, the Netherlands West Indies (as an important refining and reshipping center), Japan, United Kingdom, Germany, the Netherlands, Finland and Belgium all increased their imports of both crude and refined.

Canada, France, Italy and Czechoslovakia all increased their imports of crude while imports of refined products fell off in 1937 compared with 1933. No major importing country took increased quantities of refined products while taking less crude oil. As already mentioned the United States imported less of both categories.

Some of the reasons for these changes are obvious, others are more obscurely bound up with oil policies based on economic considerations, social objectives and military developments.

EXPORTING COUNTRIES

Russia, once considered a grave threat to the international market, has failed to fulfill her earlier promise as a result of internal disorganization leading to a slowing down in rate of increase of crude production coupled to a tremendously increasing domestic demand. Such an increased demand was a natural outcome of the program of mechanization of agriculture and industrialization of large sections of the country. At the same time pressure tending to maintain the rate of exports was lightened because of the growing independence of the Soviet Union as regards imports of goods from other countries. Requiring less foreign exchange, Russia opened at this time new sources from which to obtain such credits as were necessary by increased exports of gold and other commodities. Considering also that she had found the world markets difficult and costly to penetrate while her oil industry was not in a position to export the quality of refined products for which markets were most readily available, Russia, yielding to the force of circumstances, appears willing to play a less important role in the international market than was generally anticipated at the time of her extravagant demands in 1932.

Mexico has been able to maintain her rate of production but has not increased it sufficiently to avoid a decrease of close to 50 percent in exports of crude and refined products between 1933 and 1937. With encouragement of the extraordinary demands of labor, of which the most recent example is analyzed elsewhere in this issue, the creation of an atmosphere of uncertainty in regard to titles, concessions and future operations, the present administration could hardly have expected development to keep pace with a growing internal and world demand. As the greater part of Mexican production is in the hands of international companies, which afford a peculiarly tempting target for local politicians, it is obvious that uncertainty as to the future safety of their already large investment would act as a dam to the flow of new capital which would undoubtedly be justified if Mexico's natural potentialities

were the deciding factor. Unquestionably, the trend here pointed out will continue during this and future years, until a more realistic attitude on the part of the government again permits normal exploration of her resources.

The decrease in exports from Peru in 1937 compared with 1933 may be considered as of a strictly temporary nature. It is largely due to the partial depletion of the known oil formations and the lag in uncovering favorable new structures. This lag is accounted for by the extremely complex subsurface geology. It is understood that such progress has been made in finding deposits at greater depths and further inland that 1938 may again see a substantial increase in oil exports.

Decreasing shipments of both crude and refined into the United States during the 1933-37 period are very simply explained by the enactment of a law placing a tax of one half cent per gallon on imported crude and 2½ cents per gallon on gasoline and four cents on lubricating oil in 1932. As a result of this tariff a change in the international flow of oil occured: crude formerly shipped from South America to the United States, refined and then shipped to Europe, now by-passes United States refineries and goes from South America to the great West Indian refineries and thence to Europe. Nevertheless, due to the phenomenal growth in demand abroad, exports of crude oil from the United States have increased substantially. Since 1933 refined exports have increased moderately but have not reached the pretariff levels of 1929—in spite of the fact that demand in that year was much lower than it was in 1937. Figures for January 1938 show that this increasing trend of exports of both crude and refined is continuing.

Venezuela, Colombia and Ecuador in South America have all increased exports of crude oil, Venezuela being the most important and also showing the greatest increase in shipments of crude and refined oils out of the country. As two important concessions in Venezuela call for the construction of refineries by two different international companies, it is likely that refined exports will play an increasingly important part in Venezuela's trade.

Colombia has increased shipments of crude from 1933 to 1937 but as yet these shipments have not reached the levels established in 1929. With the active development now in progress in Colombia exports are likely to increase substantially in the next few years and the latter half of 1939 should see a big jump in exports. At that time the projected pipeline from the Barco concession to Coveñas on the Gulf of Morrosquillo on the Atlantic coast should be completed and in operation. Colombia exports no refined products nor is there any immediate prospect of her entering this field. Ecuadorian exports were also confined to crude oil. After declining slightly from 1929 to 1933, they have since greatly increased and are now substantially above the earlier figure.

Iraq and Bahrein have both entered the oil export picture since 1933 and both have already achieved positions of very considerable importance as exporting countries. Only crude is exported from Iraq. While, at various times there have been rumors of projected refinery construction at one or other terminal of the great I.P.C. pipeline, these have not been officially confirmed. Shipments out of Iraq are now confined to about 30,000,000 bbl. per year, being limited to the capacity of the pipeline. Within the next few years, however, this figure is likely to be increased by 50 to 100 percent by the construction of a second line. Most of the Iraq crude is shipped to the refineries of France.

Bahrein is one of the most interesting recent developments. With impressive reserves on this Persian Gulf island and with the completion of a modern refinery this source of petroleum avails itself of the distributing facilities of The Texas Company, one of the two companies controlling the Bahrein concession. In further development the financial backing and engineering experience of the Texas and California Standard companies cannot fail to make this island an important factor in world trade.

Roumania has increased exports of crude oil from 1933 to 1937 but has shown, during this period, a declining trend in export of refined products. While total exports from Roumania are not likely to increase much in future, due to the static nature of production, the type of export is likely to show a change during the next few years. Construction of new refineries and exten-

Snider-Triangle

Closely spaced wells in California; the state with the second largest oil reserves in the United States.

sion and modernization of existing plant will decrease the quantity of crude available for export and increase the amount of refined exports.

British Borneo is in the same position as Roumania in respect to increasing crude exports and decreasing shipments of refined products. Unlike Roumania, however, this relative position is likely to continue for the next few years as less attempt is being made to build an internal refining industry, although some refinery construction is projected.

Exactly the opposite condition prevails in Iran, Trinidad and the Netherlands West Indies. Due to the vast program of refinery modernization and new construction undertaken by the Anglo-Iranian Company, crude exports have been declining and refined products shipped from one of the world's largest refineries (Abadan) have been increasing. In Trinidad, also expansion of refinery facilities has led to increased shipments of refined products, leaving less crude available for export, with the result that this figure is lower in 1937 than it was in 1933.

The Netherland West Indies, the site of the huge Curacao and Aruba refineries of the Shell and Standard respectively, also has been increasing exports of refined products at the expense of lower shipments of crude. Strictly, these cargoes are not exports, but reshipment of oils received from Venezuela and other parts of South America. As reviewed above, with the enactment of a tariff in the United States, Venezuelan crude as such ceased in some measure to be reshipped from the West Indies to the United States. Instead, more of this crude is refined in the islands and the products are shipped to the markets of Europe.

IMPORTING COUNTRIES

As an importing country the Netherlands West Indies have taken increasing quantities of both crude and partly refined oil. While main shipments out of these islands are refined products, principal imports consist of crude.

Other countries where imports of both crude and refined increased in 1937 are: United Kingdom, Germany, Netherlands, Belgium and Finland in Europe, and Japan in Asia. Consumption of petroleum for military purposes and huge additions to storage account for increased imports into Japan. Crude imports have been increasing more rapidly than refined imports as a result of completion of new refinery capacity and also because crude can be added to storage to better advantage than refined oils. Very stringent measures are being taken to limit the consumption of gasoline in Japan for peace time uses such as prohibiting cruising of taxicabs in Tokyo. The continuation of this trend toward increasing imports is, however, very uncertain.

The situation in England is reviewed in a separate article on the following pages.

Consumption in Germany has been increasing so rapidly as a result of the encouragement given to motorists and the excellent highway system recently completed that imports of both crude and refined have increased. While the government has been bending every effort to render Germany independent of external sources of motor fuel, internal demand has increased to a point where the measures taken to increase domestic production, coal hydrogenation, and the use of substitutes is insufficient to balance consumption. It is probable, however, that the next year or two may see Germany removed from world markets as a purchaser, at least as regards refined products.

Refined imports into Holland and Finland have followed a steady but not remarkable increase over the past several years. Crude imports, which declined sharply between 1929 and 1933 have recovered by the end of 1937 to a figure considerably in excess of that achieved in 1929.

Belgium's imports of crude have increased from a purely nominal figure in 1929 to a substantial amount in 1937, as a result of refinery construction in that country. Following general business improvement from 1933 to 1937, refined imports into Belgium are up about 25 percent.

France and Italy, having embarked on a policy of refinery construction as a government oil policy, continued in 1937 the trend toward much larger imports of crude and smaller imports of refined products. France imports practically all available Iraqi crude. Her refinery construction program was completed in 1935-1936. Italy is endeavoring to supply through hydrogenation and the use of petroleum substitutes as large a part of her oil supplies as possible. She is, moreover, spending considerable sums to stimulate Albanian production, all of which is shipped to Italy. Although cost of motor fuel is now so high in Italy as to limit private demand, military requirements apparently serve to maintain consumption.

Canada and Czechoslovakia also show increased imports of crude oil and decreased imports of refined products in 1937.

In conclusion it may be said that a tremendously important source of oil is being developed in the Near and Middle East; South America continues to increase quantity of exports, as does the United States; Roumania, Mexico and Russia tend to become relatively less important sources of exports and several European countries endeavor to render themselves independent of outside oil sources or at least of imports of refined products.

INDUSTRY'S Public Goodwill Jeopardized by Gas Tax

NINETEEN years ago on February 25, the first gasoline tax in the United States was levied by the State of Oregon. Amounting to only one cent per gallon and intended for highway construction and maintenance, the tax aroused little or no opposition on the part of the relatively few motorists or on the part of the oil industry. From such humble beginnings developed a sales tax levied against a special group, having but little justification for the penalty it imposes on this group, and costing America's 30,000,000 motorists some $1,000,000,000 a year. A total of over $7,000,000,000 has been paid by motorists during these 19 years; and no relief is in sight except such as motorists can wring from state and federal governments by virtue of numbers and organization.

Unorganized groups have frequently suffered from discrimination in tax matters; but it has been amply demonstrated (by the American Legion and other groups) that an organized and articulate class of sufficient size to represent political pressure, can secure relief when sufficiently aroused.

Heretofore, motorists have not felt the full burden of the gasoline tax because advances in refinery technology, discovery of large flush fields and destructive competition in marketing served to lower gasoline prices by an amount about equal to increased taxation. The motorist was conscious only that he was paying no more for an improved product than he had been in earlier years for a much inferior fuel. At the same time he felt that the tax was being spent on the construction of roads from which he benefited directly.

Today that situation has changed. Marketing gasoline below cost is bound to become increasingly rare since the companies have divested themselves of ownership of retail outlets. Reductions in the cost of manufacture due to higher technological efficiency follows a trend of diminishing returns. Proration has eliminated the flush field as a factor in price demoralization. All indications are that gasoline prices must increase in the long term trend. If the motorist is then made to realize how large a portion of his gasoline dollar is siezed by federal and state government as a special sales tax; if it is brought home to him that over 20 percent of these taxes are diverted from road construction to government expenses having nothing to do with automobiles; if he is shown how to make his protest politically effective; then some action in gasoline tax reduction may be expected. Should the motorist fail to become aware of these facts, he will turn against the oil industry as the sole agent responsible for what he may consider an excessive price for motor fuel.

If the motorist realized that in some states he receives as little as 61 cents worth of gasoline for every dollar he spends, that over the country as a whole he pays a sales tax of 35 percent on the average, he might view the situation less complacently than he has in the past. Evidence is accumulating that motorists are becoming conscious of the tax burden they are expected to carry. Complaints have been registered in various parts of the country. To quote a single significant instance, reported by the American Petroleum Institute:

In Oakman, Ala., where motorists pay a federal tax of one cent and a state tax of six cents, constituting a sales tax on gasoline of 50.21 percent, the owners of the only five service stations in the town went on strike when Oakman imposed a local tax of one cent per gallon. The five service stations have been closed down, and, say the owners, will remain closed, until the town tax is rescinded. Residents of Oakman purchased motor fuel in neighboring towns where there is no local tax.

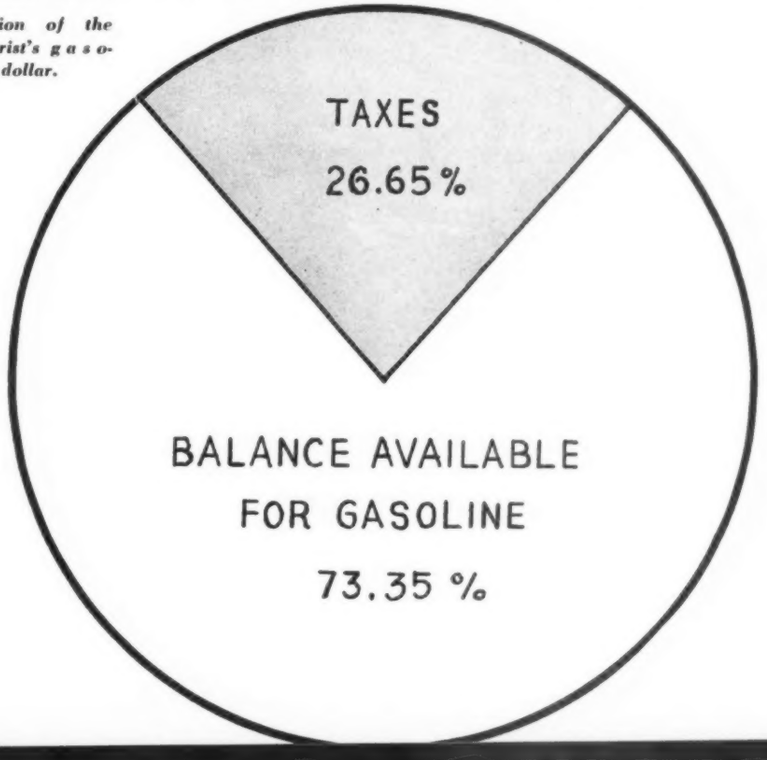
The greatest objection to the gasoline tax, is that, like all sales taxes on fundamental commodities, it is not based on ability to pay. Gasoline certainly cannot be classed as a luxury today whatever it may have been considered 19 years ago. More than half of the 30,000,000 car owners in the United States have incomes of less than $30.00 a week. And yet this class, through gasoline taxes and motor vehicle registration, pays 37 percent of the states' revenue, while real estate and personal property taxes furnish only eight percent of current states' revenue. It is obvious, however, that real estate values receive at least as much benefit as motorists through the construction and maintenance of good roads.

The objective of the motorists, of the oil and automotive industries should be, through political pressure gowing out of public education, to repeal at once the federal gasoline tax. This additional tax was imposed as a temporary emergency levy in 1932 and was to be discontinued as soon as Treasury receipts returned to normal. In 1932 federal revenue was $1,500,000,000. During 1937 federal revenue exceeded $5,700,000,000, an all-time high: but still the emergency levy is continued. Over $992,436,830 has been collected from motorists under this tax law.

After repeal of the federal emergency tax, it should become the objective of motorists and of the industry to assure a rational uniform tax on gasoline in each state. Such a tax should not exceed three cents per gallon. The only states where the tax now is three cents or less, are:

California, Connecticut, District of Colombia, Illinois, Iowa, Kansas, Massachusetts, Michigan, Missouri, New Jersey, North Dakota, and Rhode Island.

In all the other 37 states of the Union a reduction in the existing gasoline tax should be effected. And only the motorists, who as a class have allowed themselves to be discriminated against, can exert the political pressure to accomplish the necessary reductions. To the oil industry falls the task of educating and informing the public, both as justification for the cost of their product, and to relieve gasoline of a burden that limits its consumption.



Division of the motorist's gasoline dollar.

BRITISH OIL Imports Establish New Record

By Alec H. Day

EXPANSION of British internal trade was responsible for the establishment of another all-time record in petroleum imports in 1937. The total of 88,331,000 bbl. compares with 83,338,000 bbl. in 1936, representing an advance of six percent.

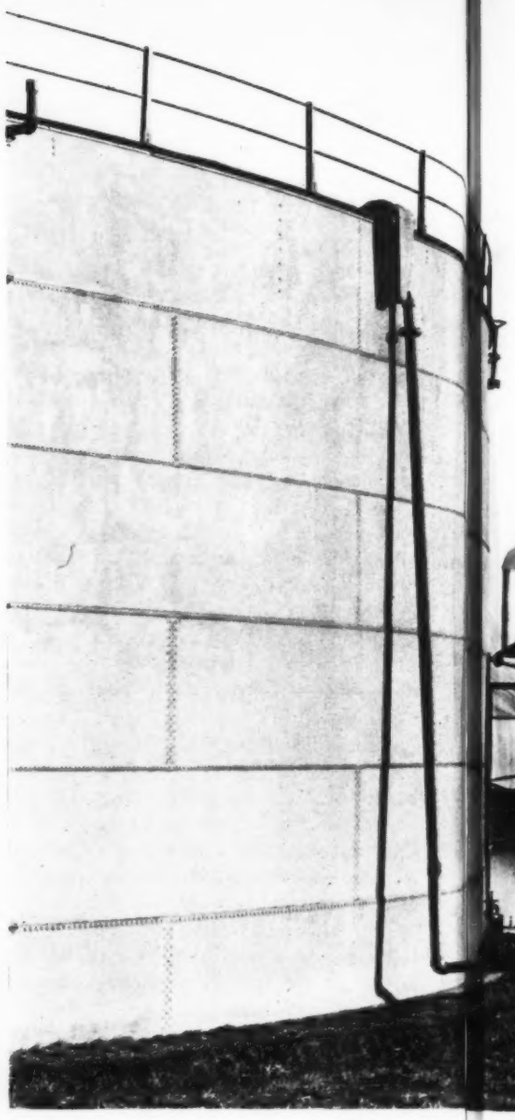
Import activity in relation to 1936 was unevenly spread during the first six months of the year. During the first quarter of 1937 the increase was under one percent, but by the end of the second quarter an advance of 8.2 percent over the previous year had been established. Subsequently, the quarterly rate of increase over 1936 was maintained at a fairly constant level.

British Oil Imports

	Volume 1937 Barrels	Increase + or decrease — percent on 1936	Value 1937 £	Percent increase on 1936
Kerosene	6,300,000	+ 3.4	3,403,682	38.9
Motor spirit	38,748,000	+ 6.9	25,586,210	28.4
Lubricating oil	3,470,000	+ 3.0	4,610,288	14.1
Gas oil	4,022,000	+29.1	1,840,878	73.2
Fuel oil	20,151,000	+ 4.1	7,304,462	44.2
Other sorts	498,000	— 9.8	373,196	28.2
Total products	73,189,000	+ 6.5	43,118,716	31.3
Crude	15,142,000	+ 3.6	5,011,752	19.2
Total imports	88,331,000	+ 6.0	48,130,468	30.0

Relatively heavy imports during the second quarter evidently made good the low level in the January-March period, and coincided with a high rate of industrial production in Britain. Figures for the two last quarters of the year, although below those reached in April-June, do not disclose a serious set-back. Figures for the fourth quarter certainly show a reduction compared with those for the third, but the decline may be attributed to a considerable extent to seasonal influences. At the end of the September quarter the advance in imports was only 5.6 percent above the corresponding nine months of 1936. By the end of the year the increase had risen to six percent, so that the decline in import business during the closing three months of 1937 was less pronounced than in the previous year. On a superficial view, therefore, oil import figures do not bear out the suggestion of a set-back in British industrial activity at the close of 1937.

British oil import statistics, however, may be distorted at the present time by the movement in Britain for increased national storage, recently initiated and supported by the government as some provision for war or other emergency. There is just a possibility that actual consumption of petroleum in the country declined towards the close of last year more substantially than the statistics show, for the effect of such a decline in demand may have been offset by a rise in the country's stocks. No statistics are available to show how far this process has been in operation.

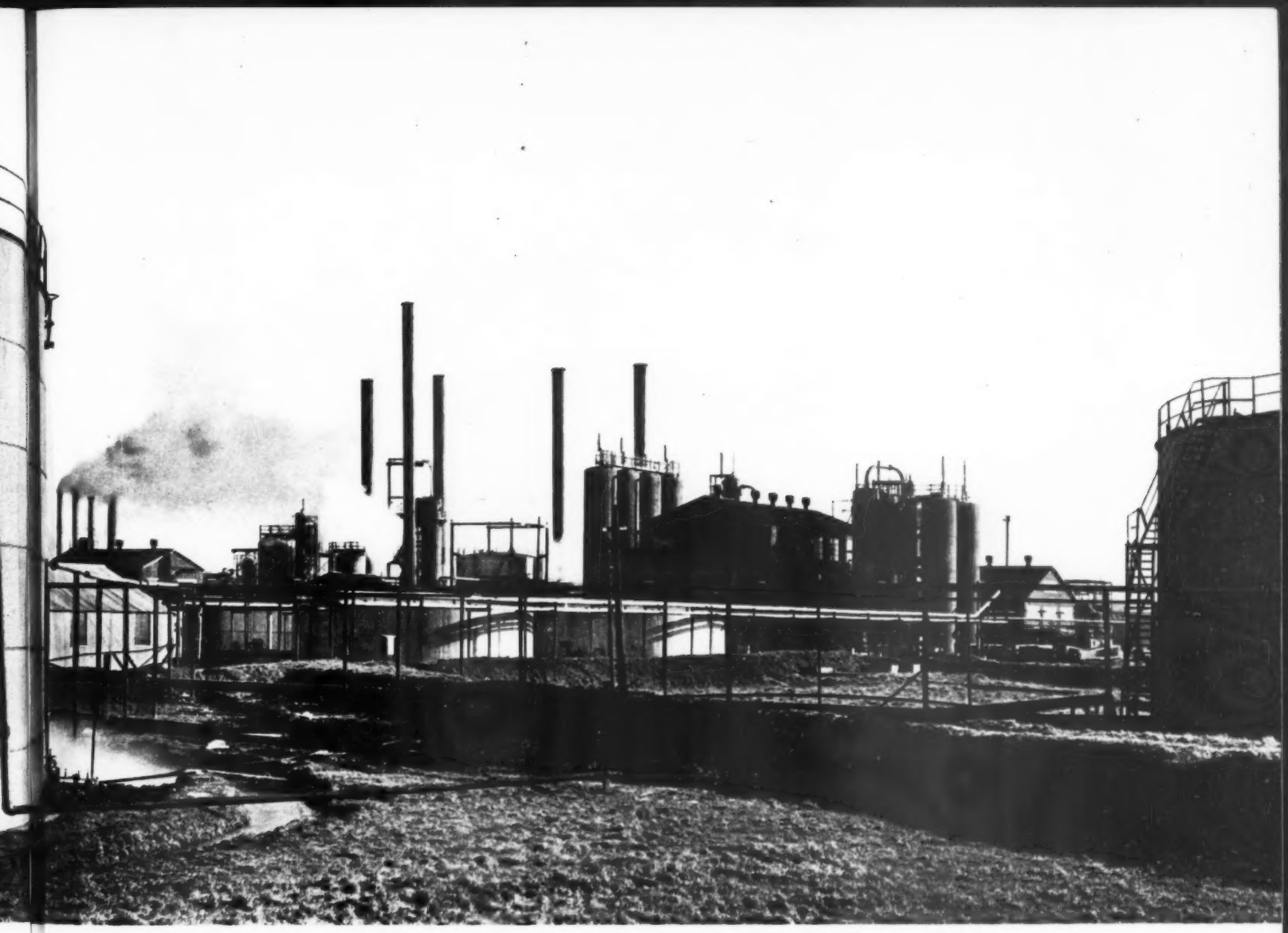


Increased industrial activity in Great Britain has caused the important domestic concerns to concentrate on production of high-quality lubricating oils, for which purpose some four plants have been specially built. Expansion of storage facilities has resulted in large purchases of tankage.

British Oil Import Trend During 1937

	Quarter's imports (barrels)	Total imports to end of quarter (barrels)	Percent increase on 1936
First	19,652,000	19,652,000	0.7
Second	24,334,000	43,986,000	8.2
Third	22,980,000	66,966,000	5.6
Fourth	21,365,000	88,331,000	6.0

Published c.i.f. values of imports of oil into Britain have shown a rise last year against those for 1936, and the rise is strikingly illustrated in the accompanying table of the volume and value of the year's imports.



While the volume of imports increased by 6.0 percent during the year, the value rose by 30 percent. This indicates that the average unit value of all imports for the year was 122.7 percent higher than in 1936.

Among the major categories of imports shown in the table, the price rise was most pronounced in fuel oil. Volume of imports of this product rose by 4.1 percent, but the value advanced by 44.2 percent. A partial explanation of this rise in import prices is the greatly increased use of Diesel engines for road transport. Diesel oil is classified in the Trade Returns under fuel oil, and doubtless accounted for a larger proportion of total imports under this head, with a consequential rise in the average price.

Motor spirit imports increased in volume by 6.9 percent, during the year, but the value rose by 28.4 percent. The percentage increase in the average import price of motor spirit increased by comparison of these percentages, is nearly 20 percent against 1936. This advance in the import price is considerably larger than the rise in the average selling prices of motor spirit for the year, suggesting a smaller gross profit for distributors in Britain who purchased their supplies. Profit margins of the big distributing groups in Britain, taking their supplies from their own organizations, would not be affected by this factor. The large rise in average import values, as compared with the rise in selling prices, suggests, nevertheless, that the latter are being kept well in touch with world motor spirit values.

Relative importance of the main sources of British oil supplies remains unchanged. The Netherlands West Indies was again easily the largest supplier, with a total of 32,621,000 bbl. of all products. Iran again took second place and the United States third.

Roumania was the only important exporting country to lose ground in British oil import business. The aggregate received from that country declined from 5,594,000 bbl. in 1936 to 4,069,000 bbl. last year. Roumanian export trade is now largely bound up with exchange clearing and other agreements, and the decline in Roumanian oil exports to Britain may well be explained by the trade position existing between the two countries.

Russia continues to occupy a small place in British import trade, partly owing to the general decline in Russian export business consequent on increased internal demands. A decline in Russian exports of lubricating oil to the British market took place in 1937, and is probably due, in part at least, to the improvement in lubricating oils produced from other quarters, and their consequent substitution for Russian products.

A substantial decline in British imports of crude oil from Iraq took place during the year. The total was only 3,373,000 bbl. compared with 4,204,000 bbl. in 1936. This reduction is not attributed to any current deficiencies in the properties of Iraq crude, but, to a change in the shipping policy of the group controlling the Iraq oil industry. Last year reduction in British crude imports from Iraq was made good by larger shipments from Venezuela and the Netherlands West Indies.

WORLD SURVEY Indicates Future Increases in Oil Consumption and Prices

By K. Dijk and K. Mulders

Royal Dutch-Shell

Distinguished Statisticians of the Royal Dutch-Shell Anticipate That Increases in Consumption Combined with Scarcity of Known Sub-surface Reserves Will Lead to a Rising Trend in Oil Prices on the World's Markets.

THE MAIN purpose of this review is to treat this wide subject from the economic and statistical aspect, and to find mutual relations and proportions. In general, the period covered is that between the economic peak year, 1929, and approximately the beginning of 1938.

PRODUCTION

As may be seen in Table I, the United States remains unchallenged as the leading producer, with a proportion of about 60 percent of the total. Nor as regards the second place, held by Russia, has there been any change since 1930. Venezuela made such good progress in 1937, however, that it is now not very far behind Russia. It has a very good chance in the near future of recapturing second place—held in 1928 and 1929—and it will then probably retain it for a longer period.

Of the major producing countries the United States, Russia and Venezuela show the greatest increases in 1937 as compared with 1929, the increases being 34,000,000, 15,000,000 and 7,000,000 metric tons respectively.

An increase of nearly 33,000,000 tons in total petroleum output in any one year has never before been witnessed in the history of the petroleum industry, and one has to go back 10 years to find anything like an equal percentage rise.

Some remarkable changes have taken place in the picture during the past year. Russia, although it delivered about a million tons more, and Roumania have both lost their relative importance. As compared with these two European producers, other countries have come to the fore, especially Venezuela, Iran, Netherlands East Indies and, last but not least, Bahrein. The latter, in fact, shows the largest percentage increase. Netherlands Indian output now equals that of Roumania.

The accompanying Table II, based on accurate calculations, gives the accumulated quantity of crude oil produced since the foundation of the industry.

TABLE II

World Oil Production

	Total Per Period	Accumulated Total
	Millions of Metric Tons	
1857-1909	511	511
1910-1919	574	1,085
1920-1929	1,475	2,550
1930	201	2,761
1931	188	2,949
1932	180	3,129
1933	197	3,326
1934	208	3,534
1935	226	3,760
1936	247	4,007
1937 (estimated)	280	4,287

From 1910 up to and including 1919 the industry produced considerably more than in the preceding 50 years. The production curve in the seventh decade is still steeper, so that the total output in that period exceeds the aggregate of the whole of the previous 60 years by 35 percent.

After 1929 three years follow in which production declined temporarily to 180,000,000 metric tons. For 1937, however, a record output of some 280,000,000 metric tons may be expected, thus bringing the aggregate from the industry to just over the 4,250,000,000 metric ton mark.

According to the latest estimates of Garfias and Whetsel, world petroleum reserves, based on present production methods, are just half exhausted. Based on the production rate of the last few years, this means that all crude oil reserves will have been used up after about 16 years.

Such a statement must not be regarded as a prophecy that within less than 20 years the world will be without petroleum, but it is irrefutable that we are rapidly exhausting irreplaceable wealth. This was typically expressed by a sensible man in the following words.

"Petroleum is not sugar, yielding a new crop every year."

Take, for example, the United States, the world's largest producer. Since 1900 various estimates have been made by competent persons, both as regards proven reserves (producible oil) in well-known fields, reserves of fields still to be discovered, and oil that must remain underground. Although the latter quantity forms an appreciable percentage of the total, it is left out of consideration in these calculations.

United States Production and Reserves

Period—	Production Million Barrels	Production Million Metric Tons	Proven Reserves Million Barrels	Proven Reserves Million Metric Tons
Year ended Dec. 31, 1924	7,900	1,059	5,300	711
10 years ended Dec. 31, 1934	8,700	1,192	.....	.....
Total to Dec. 31, 1934	16,600	2,251	13,600	1,859
Two years ended Dec. 31, 1937	2,995	284	13,100	1,780
	19,595	2,535		
Year ended Dec. 31, 1937	1,274	173		
Total to Dec. 31, 1937	20,869	2,708		

Taking production and reserves together, the total quantity of recoverable oil considerably more than doubled in the 10 years ended December 31, 1934. In other words, it totalled 30,200,000,000 (4,111,000,000 metric tons) as against 13,200,000,000 bbl. (1,770,000,000 metric tons) at the beginning of this decade.

TABLE I

World Crude Oil Production

Millions of Metric Tons

Country	1929	1930	1931	1932	1933	1934	1935	1936(e)	1936(a)	1937(e)
United States	139.22	123.78	115.35	106.97	122.55	122.48	134.48	150.00	149.3	173.0
Russia	13.68	22.63	22.40	21.41	21.48	24.20	25.13	27.00	27.8	28.6
Venezuela	20.09	19.79	16.99	16.96	17.29	20.11	21.99	23.20	22.9	27.0
Iran	5.55	6.03	5.84	6.55	7.20	7.66	7.61	8.30	8.3	10.2
Roumania	4.83	5.74	6.66	7.35	7.39	8.47	8.39	8.80	8.7	7.2
Netherlands Indies	5.10	5.42	4.59	4.97	5.42	5.91	6.06	6.50	6.4	7.2
Mexico	6.66	5.89	4.91	4.86	5.01	5.59	5.87	5.90	5.9	6.6
Iraq	0.11	0.12	0.11	0.01	0.10	1.07	3.73	4.20	4.1	4.1
Colombia	2.84	2.83	2.54	2.34	1.85	2.48	2.51	2.60	2.7	2.9
Peru	1.81	1.68	1.36	1.34	1.78	2.19	2.29	2.30	2.3	2.4
Argentina	1.34	1.28	1.66	1.87	1.94	1.99	2.03	2.20	2.2	2.2
Trinidad	1.34	1.45	1.49	1.47	1.39	1.56	1.71	1.80	1.9	2.2
British India	1.23	1.25	1.23	1.24	1.23	1.29	1.29	1.30	1.3	1.3
Others	2.69	2.81	2.69	2.46	2.54	2.73	2.99	3.30	3.5	5.1
Total	206.49	200.70	187.82	179.80	197.17	207.73	226.08	247.40	247.3	280.0

(e) Estimated. (a) Actual production.

This increase in the total figure can be ascribed as to 97 percent to the discovery of new fields. Improved production methods have only accounted for a negligible proportion.

However, in the years 1935 and 1936 combined production amounted to about 3,000,000,000 bbl. but proven reserves only diminished by 500,000,000.

This may seem a favorable state of affairs. As a matter of fact, the picture is far from encouraging and in the last few years the situation has completely altered.

During the first period there was a net annual addition to reserves of 830,000,000 bbl., whereas in the last two years proven reserves have declined some 250,000,000 bbl. a year. And that in spite of the fact that the methods by which these calculations and estimates are made have improved in the course of time, and their reliability has become greater and greater.

During the last few years more oil has been consumed in the United States than has been added to reserves by the discovery of new fields.

The discovery second in importance to East Texas is that of the Conroe field, with a maximum capacity of 800,000,000 bbl., and this is already more than six years old. To compensate for the decline in reserves caused by consumption would necessitate the discovery of a field every year with a capacity 60 percent greater than Conroe.

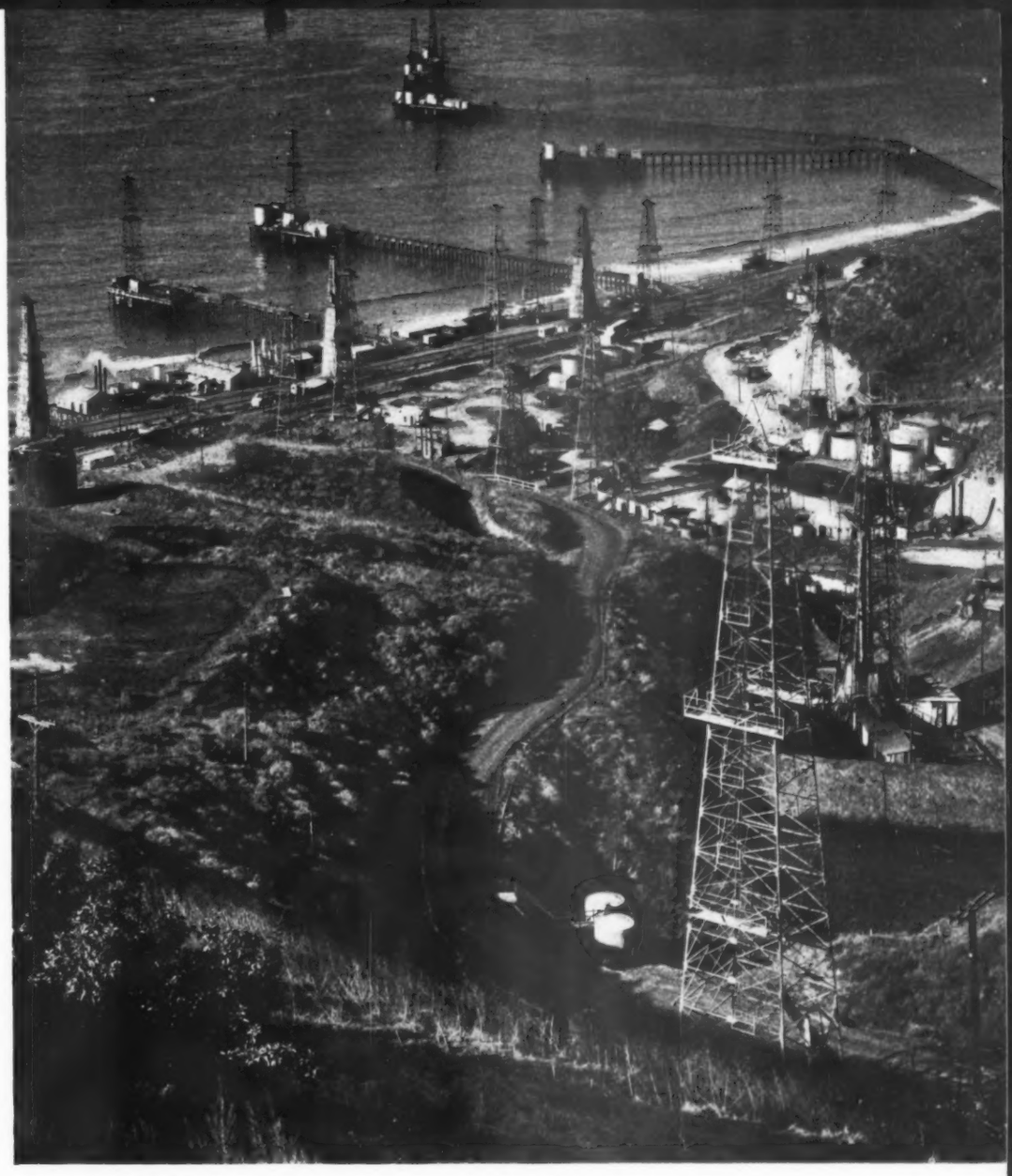
Among the fields discovered in 1934 and 1935 only Anahuac and Rodessa are worthy of mention. These together may contain 800,000,000 bbl., comparing with total production during these two years of 1,900,000,000 bbl.

Only discovery of a field like East Texas, the largest American field to date, with a maximum capacity of 4,000,000,000 bbl., would suffice to compensate for three to four years' consumption.

Discovery of new fields in the United States has slowed up in the last few years. Thus by reason of ever-increasing consumption the possibility will have to be taken into account that shortage of crude petroleum may very well arise in the not-too-distant future.

Considering the position which oil will assume in the future as a source of energy, especially as compared with coal, wood and water power, the conclusion drawn from the foregoing must be a pessimistic one. On the other hand, it must be a moderately optimistic one as regards the financial position of the petroleum industry for the next few years.

It is true that water power is of little significance as yet. Even taking into consideration that existing plants are working at one-third of their total capacity, while only one-ninth of the available power is being employed, water power under present circumstances would only be able to supply 15 percent of all the energy required. On the other hand is the fact that this power does not diminish appreciably in the course of years.



Drilling in the ocean in an attempt to maintain declining U. S. reserves.

TABLE III

World Sources of Energy

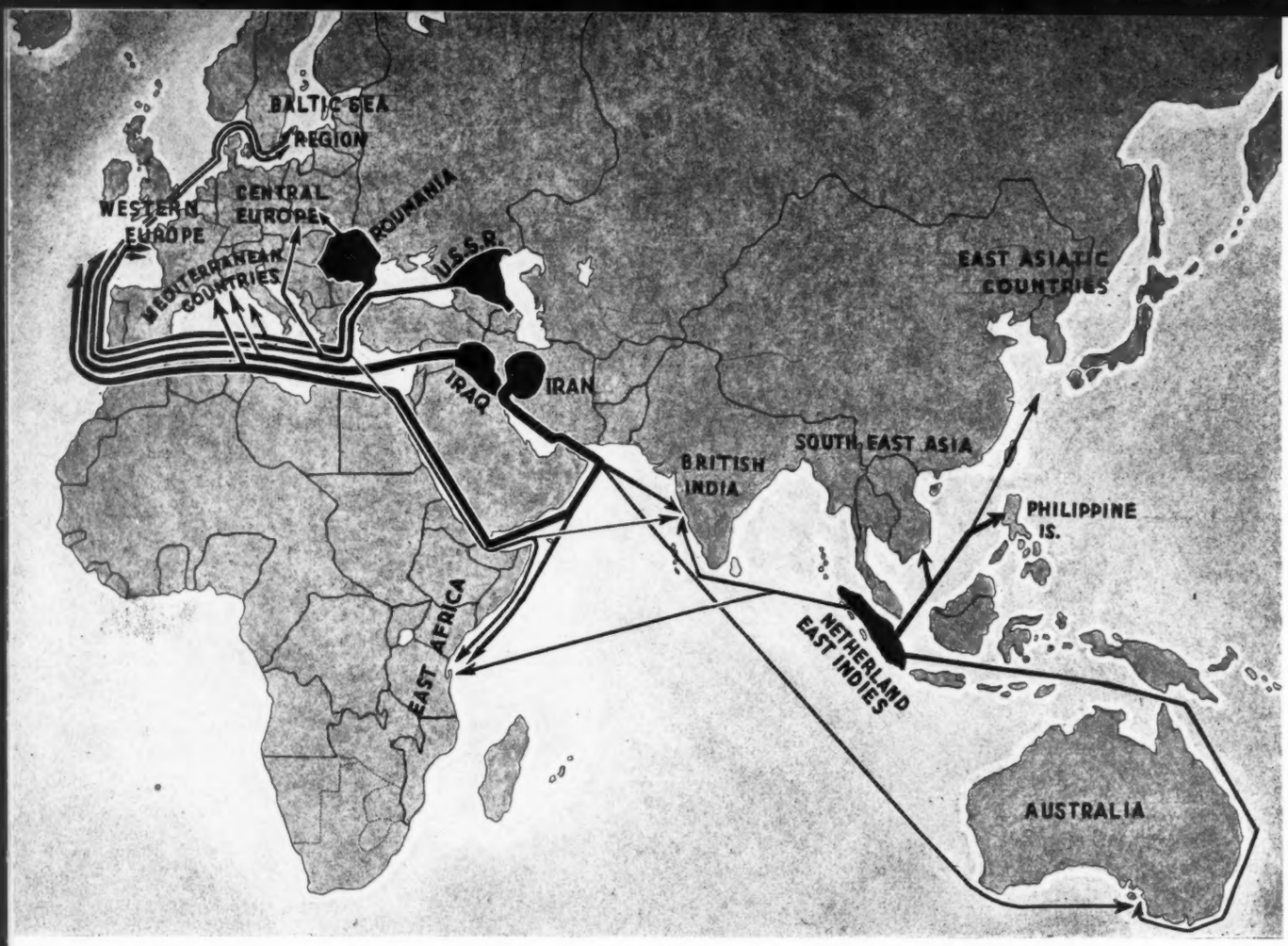
	In Units of 10^{11} Calories	In Percent
Coal	91.3	72.5
Oil	22.5	17.9
Natural Gas	3.6	2.9
Wood	6.7	5.3
Peat	1.0	0.8
Water Power	0.7	0.6
	125.8	100.00

As is evident from the approximate values of the various forms of energy given in Table III, oil does not occupy a predominant position in the world's energy supply. Only about one-sixth of all energy together (light, motion, heat) is supplied by oil, and this would become relatively smaller if production cannot be increased considerably in the future.

Since it may be assumed that oil search has been far more intensive in the United States than in the rest of the world, the pessimistic conclusion at present drawn for the greatest producer need not be true for countries like Venezuela, Colombia, Peru, Iraq, and Iran, and for areas like Central Asia and China, which possess, to a far greater extent, unlimited possibilities.

Sub-surface oil reserves will have to be drawn on with the greatest prudence, and the products required will have to be worked with the greatest care, if the petroleum industry is to maintain or improve its position in regard to energy supply.

Exports from producing countries and imports into consuming regions, during the years 1929 to 1936 are presented as a con-



The flow of oil from principal producing-exporting areas to main consuming centers, in the Eastern Hemisphere.

cise picture in Tables IV and V. Exports from Trinidad, Ecuador, Egypt, Bahrein, and Sarawak are missing from Table IV, but as their total export is only 2,000,000 to 3,000,000 metric tons they do not affect the picture materially.

During this eight-year period exports have been almost constant at somewhat over 30 percent of world production. Actual export surplus (American imports deducted) amounted to approximately 50,000,000 metric tons during 1929 to 1933, and has risen considerably during the last few years and in 1936 was 65,000,000 metric tons. Percentage of net world exports, expressed on production, was about 25 percent with a rising tendency.

Dealing now with individual countries, we find that Venezuela has for some considerable time occupied the foremost place with a figure of some 24,000,000 metric tons, or about 30 percent of the total.

In the last few years the United States has started exporting to a high degree and about proportionate to production increase. Export surplus of oil fell from 7,000,000 metric tons in 1929 to 3,000,000 in 1932. It rose again to 9,000,000 metric tons in 1935, but declined slightly in 1936.

Roumania, Iraq and Netherlands East Indies are likely to occupy, to a greater or lesser extent, a predominant place in export movements, while, from a quantitative point of view, Mexico, Colombia and Peru remain on the same level as regards oil transport.

Russia, as is well known, is increasing its consumption of domestic oil, a fact which is evident from a comparison of production and export figures.

By far the greater part of international oil movements are by sea. For example in 1936 the quantity conveyed by tankers was about 75,000,000 metric tons and was probably 80,000,000 metric tons in 1937.

Taking the total carrying capacity of the world tanker fleet at 12,000,000 metric tons, this means an average of 6.25 voyages for each tanker in 1936. For the seven previous years the average number of voyages was 7, 6.8, 5.4, 5.1, 5.1, 5.9 and 6.2.

A year ago, when preparing a similar review for the Second World Petroleum Congress, we wrote:

> "In the future this figure should become more favorable, since consumption is increasing to a greater extent than available tonnage, which fact cannot fail to affect tanker freights favorably."

The course of freight rates in 1937 has clearly proved the correctness of this forecast, but at the present moment the situation has changed somewhat. Total load capacity of the world tanker fleet has increased by eight percent so that there is no certainty about the future trend.

A more efficient adjustment of areas to be supplied with oil will do much to prevent undue transport.

Among American producers, the United States and Venezuela send their oil to almost every part of the world, the latter country mostly after the crude has been refined in Curacao and Aruba. Practically no oil is moved in the opposite direction from Eurasian producers to the American Continent.

Since 1932 countries outside the United States have obtained a more or less constant quantity of 22 to 23 percent of their imports from that country.

The area to be supplied by Netherlands East Indies also extends to Western Europe and Mediterranean countries, although the principal areas are Southern and Eastern Asia and Australasia. It should be noted, however, that Eastern Asia, and especially Japan, are likely to be supplied also from America.

When surveying oil movement as a whole we find different tendencies throughout the world's oil currents. As a rule exporting countries first supply their immediate neighborhood, although the extent of this area depends largely on export surplus and the requirements of surrounding countries.

Areas supplied by neighboring exporting countries partially overlap, but a gradual and distinct shifting is noticeable, as illustrated by the accompanying map, which shows but a few of the producing centers and consuming regions.

In Table V importing countries have been grouped into consumption areas in, as far as possible, geographical sequence. Not only does this simplify consideration but it also enables tendencies to be more easily traced. In these, as in other statistics, quantities obtained from other sources require to be taken into account.

Western Europe is the principal importing area and like the Mediterranean area, it attracts not only American oil but also a large portion of the oil from Roumania, Russia, Iraq and Iran.

Colombia suffering to the greatest extent, and there is no doubt that differences in quality and protective duties played an important part in this respect. Since 1933, imports have again risen but have not yet by any means reached the 1929 level.

Canada, the fifth largest consumer in the world, has to import 96 percent of its oil requirements. The United States is the main supplier, and other American producers hold a constant, but much smaller, share.

In Central American, West Indian and South African markets, and even to a great extent in Western Europe, oil from the United States has been ousted by that from Venezuela.

Summarizing the above survey of oil movements, it has been shown primarily that Venezuela is one of the most important stable suppliers of crude oil, and it is to be hoped that that country will be able to maintain its position at least until other existing or new areas are able to take over its task.

Future oil supply policy will, more than ever, have to be directed towards efficient and economic allotment of production to consuming areas.

These conclusions regarding international oil movements are not drawn alone from the data given in Tables IV and V; these contain only the principal data extracted from a series of 25 tables which the authors have prepared and considered.

TABLE IV

Exports

(Thousands of Metric Tons)

Exporting countries—	1929	1930	1931	1932	1933	1934	1935	1936
Venezuela and Curacao (e)	19,284	20,461	17,345	17,464	17,557	19,681	21,500	24,000
United States	21,082	19,967	15,860	13,207	13,515	14,560	16,900	17,597
Roumania	2,846	3,866	4,669	5,166	5,885	6,547	6,611	6,671
Iran	5,500	5,500	6,425	5,239	5,717	7,275	7,124	6,654
Netherlands Indies	3,772	4,223	3,394	3,893	4,336	4,847	5,033	5,160
Iraq	—	—	—	—	—	617	3,504	3,751
Mexico (e)	3,695	2,786	3,076	3,088	3,002	3,740	3,256	3,500
Russia	3,815	4,803	5,223	6,012	4,895	4,306	3,354	2,346
Colombia	2,577	2,656	2,371	2,208	1,684	2,349	2,279	2,291
Peru	1,509	1,414	1,158	1,086	1,536	1,923	1,972	1,930
Total exports	64,080	65,676	59,521	57,363	58,127	65,845	71,533	73,900

(e) Estimated.

Of the total of 27,000,000 metric tons emanating from the large producers, certain quantities are predestined, approximately as follows:

Importing Areas in Western Europe	Million Metric Tons
Great Britain	11.1
France	6.8
Germany	4.4
Holland	1.3
Others	0.8
Total	24.4

Included in the above is a considerable quantity, particularly in Great Britain (1,300,000 metric tons), France and Holland, which is used as bunkers for vessels in foreign trade.

It may also be assumed that the smaller producing countries together export a further 1,000,000 tons to Western Europe. Thus, including losses, it would appear that about 3,600,000 metric tons is consumed elsewhere.

Mexico, Roumania and Iraq have come to the fore in the eight years under consideration for the provision of Western Europe.

In regard to Mediterranean countries, a discrepancy is noted between supply and consumption. Against imports of 7,000,000 metric tons there is a consumption of 5,000,000 metric tons, and it is probable that most of the difference is consumed in the hinterland.

United States imports from 1929 to 1933 decreased by about half. All producing countries shared in this decline, Mexico and

CONSUMPTION

Transport and oil are closely connected, for the transport industry is dependent for its energy-suppliers, such as gasoline, Diesel and fuel oil, on the oil industry. The latter also supplies bitumen and lubricating oil which, indirectly, accelerate traffic.

On the one hand, development of the oil industry keeps pace with the extent of traffic and that of other industries, which directly or indirectly are their consumers, while on the other hand oil consumption is stimulated by the fact that it is more and more replacing other sources of energy.

This preference for oil is based on its greater efficiency as fuel, on hygienic considerations and on the ease of operation of oil-driven engines. Where maximum speed or comfort is required oil is used. In so far as oil consumption is dependent on traffic and industry, it will rise and fall with their activities, and the depression in the last few years has, therefore, not failed to make a considerable dent in the consumption curve.

That the oil industry was 80 percent of the normal in the depression years as compared with 45 percent for the metal industry is due to this ever-growing preference for oil. This is further demonstrated by increase in motor transport at the expense of railways and the large percentage of the world's ships driven by oil.

This factor had an even greater effect in the previous depression of 1921, when consumption of kerosene and lubricating oil declined whereas gasoline and heavy oil continued to increase.

Influence of this replacement in favor of oil was already slighter in 1932 than in 1921 and consumption of all products suffered a shock. Subsequently the rise was continued.

In the future, as the movement in favor of oil approaches saturation point so will oil consumption become more dependent on the general economic situation, and the trend of consumption curves points in this direction. Oil consumption will, therefore, become more sensitive to general economic conditions.

Total world consumption of oil products in 1932 amounted to about 177,000,000 tons and in 1936 had risen to about 233,000,000, an increase of 32 percent.

Except in a few cases consumption statistics are not available or are very incom-

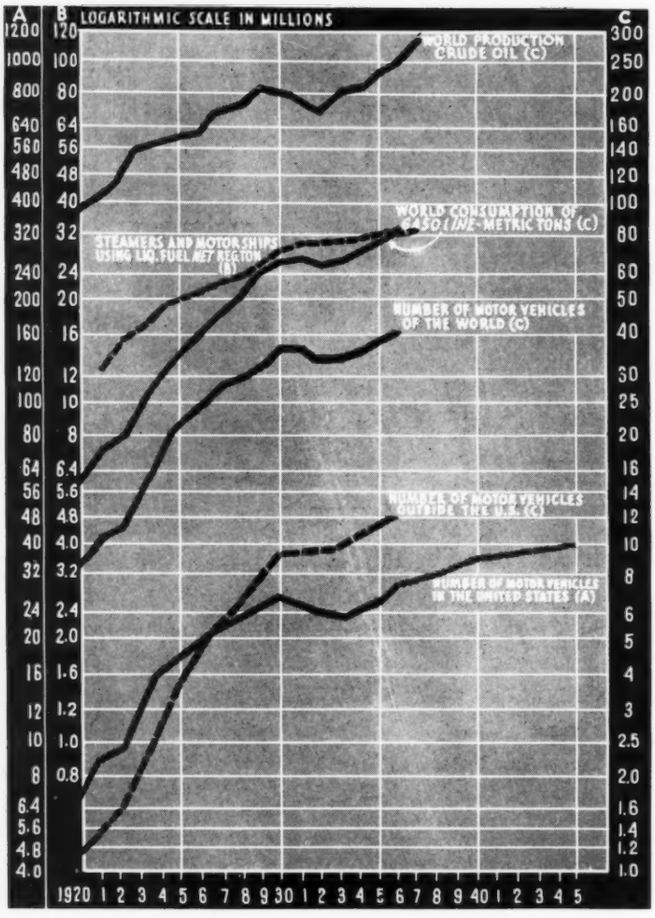
TABLE V

Imports

(Thousands of Metric Tons)

Import-Regions—	1929	1930	1931	1932	1933	1934	1935	1936 (e)
Canada	5,273	4,962	4,750	3,920	4,347	4,674	5,203	5,572
United States	13,889	14,268	11,980	10,490	6,970	7,582	7,952	9,157
Central America and West Indies	6,233	4,151	2,625	3,480	3,257	4,549	4,686	4,238
West Coast South America	1,843	885	579	210	313	398	655	446
East Coast South America	3,212	3,596	2,685	1,960	2,328	2,588	3,309	2,520
Europe—Baltic Sea Region	1,072	1,091	1,379	1,358	1,319	1,569	1,254	1,764
West Europe	17,515	19,744	19,360	18,757	20,880	23,624	25,315	27,000
Central Europe	748	934	605	641	738	837	1,092	1,078
Mediterranean Region	5,090	5,399	5,712	5,550	6,094	6,875	7,109	6,679
West Coast Africa	383	522	694	793	1,022	697	1,039	673
East Coast Africa and British India	1,606	1,823	1,695	1,507	2,134	2,430	2,241	3,026
S.E. Asia, Incl. Philippines	2,638	2,959	2,459	2,401	2,406	2,719	3,049	3,542
Australia	1,503	1,396	1,029	1,293	1,370	1,479	1,669	1,504
East Asiatic countries	2,677	2,573	2,452	3,100	3,202	3,587	4,182	4,201
Other countries	998	1,373	1,517	1,903	1,747	2,237	2,778	2,500
Total imports	64,080	65,676	59,521	57,363	58,127	65,845	71,533	73,900

(e) Partly estimated.


A
B
LOGARITHMIC SCALE IN MILLIONS
C
WORLD PRODUCTION CRUDE OIL (C)
WORLD CONSUMPTION OF GASOLINE-METRIC TONS (C)
STEAMERS AND MOTOR SHIPS USING LIQ. FUEL NET REGTON (S)
NUMBER OF MOTOR VEHICLES OF THE WORLD (C)
NUMBER OF MOTOR VEHICLES OUTSIDE THE U.S. (C)
NUMBER OF MOTOR VEHICLES IN THE UNITED STATES (A)
1920 1 2 3 4 5 6 7 8 9 30 1 2 3 4 5 6 7 8 9 40 1 2 3 4 5

Graphic representation of the relation between oil consumers and oil production.

plete. Generally they are derived from import, export or trade returns, and consequently it is impossible to separate actual consumption from stock appreciation. It is probable that many countries are accumulating stocks of oil and these are, therefore, included in consumption figures.

The only countries that regularly publish data regarding stocks are the United States, Mexico and Roumania.

In the United States, which is the most important country both as a producer and a consumer, the stock position is somewhat complicated. The position in recent years can be summarized as indicated in Table VII.

United States stocks of crude oil, expressed as days' consumption, dropped from 150 in 1932 to 105 on August 1, 1936, after which the decrease continued at a greater rate until it reached the lowest record of 90 days at the end of September, 1937. However, the quantity was 9,000,000 bbl. higher than a year previously. At the end of 1937 it was probably about 93 to 94 days, still lower than at the end of 1936, and such a decrease has never before occurred in the history of the United States oil industry.

TABLE VI
World Oil Consumption

Year	Gasoline	Kerosene	Lubricating Oil	Gas and Fuel Oils	Other Products	Gasoline	Kerosene	Lubricating Oil	Gas and Fuel Oils
	(In Millions of Metric Tons)					(In Percent of Crude Oil Production)			
1913	5.3	7.5	2.6	22.0	....	9.6	13.7	4.7	40.2
1914	5.8	7.7	2.5	23.0	....	10.0	13.3	4.3	39.8
1915	6.6	7.2	2.6	24.8	....	10.8	11.8	4.3	40.5
1916	7.8	7.3	2.9	28.9	....	11.8	11.1	4.4	43.8
1917	9.2	7.9	3.4	28.3	....	13.7	11.8	5.1	42.3
1918	11.3	8.1	3.8	31.0	....	17.1	12.3	5.7	46.9
1919	12.8	9.7	3.6	33.0	....	16.6	12.6	4.6	42.7
1920	15.4	9.9	4.1	35.3	....	13.6	10.0	4.1	35.8
1921	16.9	9.1	3.8	42.9	....	15.7	8.5	3.5	40.0
1922	20.5	10.3	4.4	46.6	....	17.3	8.7	3.7	39.4
1923	25.1	10.6	4.6	53.8	....	17.8	7.6	3.3	38.3
1924	29.2	11.1	5.1	58.1	....	20.5	7.8	3.5	40.7
1925	35.6	11.8	5.5	63.2	....	23.8	7.8	3.7	42.3
1926	41.6	12.5	6.0	66.4	....	27.2	8.2	3.9	43.4
1927	46.2	12.4	6.3	70.9	....	26.4	7.1	3.6	40.5
1928	53.1	13.4	6.7	85.4	....	29.0	7.3	3.6	46.7
1929	60.0	13.8	6.8	87.0	....	29.1	6.7	3.3	42.1
1930	65.2	14.0	7.0	88.0	....	32.5	7.0	3.5	43.8
1931	65.9	14.7	7.2	87.2	12.9	35.1	7.8	3.8	46.4
1932	63.0	13.4	5.8	73.3	21.6	35.0	7.5	3.2	43.5
1933	64.5	14.4	6.1	82.1	24.0	32.7	7.3	3.1	43.3
1934	68.5	15.3	6.5	85.4	21.2	32.8	7.3	3.1	41.0
1935	73.2	16.4	7.1	90.6	25.0	32.8	7.3	3.2	40.5
1936 (e)	81.0	17.5	7.5	101.0	26.0	32.7	7.0	3.0	40.8
1936 (m)	78.5	16.6	7.2	101.0	27.7	....	....	....	....

(e) Estimated. (m) According to Moniteur du Petr.

TABLE VII
United States Oil Stock Position

	Crude Oil		Gasoline		All Oils	
	1,000 Barrels	Days' Supply	1,000 Barrels	Days' Supply	1,000 Barrels	Days' Supply
November 1, 1935	317,155	114	44,373	34	546,855	165
November 1, 1936	292,271	98	51,238	36	527,431	148
November 1, 1937	308,472	93	61,141	41	563,137	150
January 15, 1938	303,679	..	82,785	..	.....	..

When comparing gasoline stocks over the corresponding months of the last three years it is seen that, although there was a sharp increase in quantity, the number of days' supply rose only slightly. Aggregate stock position of all oils in the United States is very favorable, a steady decline being observed in days' supply over the three years.

A rising tendency in world oil consumption commenced in 1935 and continued at a higher rate in the following two years, the figures for the United States and Europe in 1936 being more than 10 percent higher than in the preceding year.

All products have not shared equally in this rising tendency, as will be seen from Table VI and the accompanying charts. Comparing, for example, increase in crude oil production with the consumption of the principal products over the period 1922 to 1936, we have the following:

	Crude production	Consumption				
		Gasoline	Kerosene	Gas and Fuel Oils	Lubricating Oil	Other Products and Loss
	Million Metric Tons					
1922	118	20.5	10.3	46.6	4.4	36.2
1936	247	81.0	17.5	101.0	7.5	40.0

Thus, while crude oil production doubled gasoline consumption quadrupled and the aggregate consumption of kerosene, gas oil, fuel oil and lubricating oil increased almost proportionately to crude oil output. Other products increased by 12 percent.

The reason for making the comparison between these two widely separated years is that increase in consumption after the year of maximum depression can hardly be taken as a criterion. As a matter of fact, fuel oil consumption rose from 73,000,000 metric tons in 1932 to 101,000,000 in 1936, against gasoline from 63 to 81,000,000 metric tons. Fuel oil consumption in 1932, however, decreased to a greater extent than that of gasoline.

Modern and more efficient distillation processes had made it possible to raise gasoline output to meet the greatly increased demand. Should gasoline requirements increase in the future to the same extent, then the percentage of gasoline—assuming

the same market position and working methods that are at present economically possible—could not be further increased to any appreciable extent.

Factors which are hampering an increase in gasoline demand are already to be found in the more economical operation of gasoline engines and in the rising popularity of compression-ignition engines. These factors are not such as would prevent a rise in price and this might result in an increase in gasoline output, since processes which are already technically possible would then become economically possible.

We have noted how, in such countries as Germany, Great Britain and Japan, production of motor fuel by coal hydrogenation already has been developed and will further develop, although the reasons are quite different from those mentioned above.

We shall now discuss consumption of a few individual oil products and their principal consumers, such as motor cars, ships, railways, domestic use and within the oil industry itself.

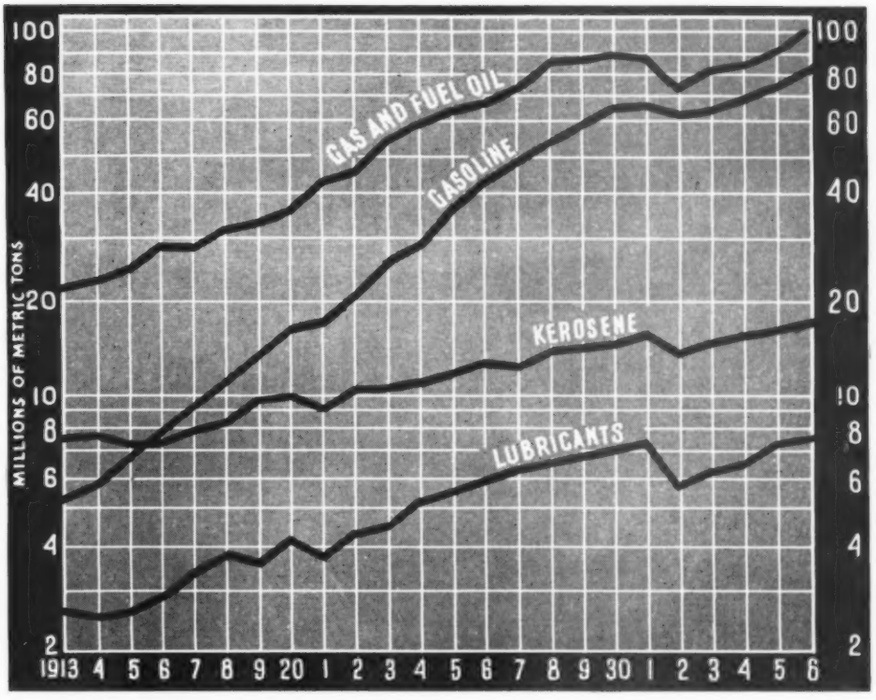
With one exception there is a remarkable parallelism between the curves of the chart which shows the relation between consumers and producers in the growth of the oil industry. In addition to the number of motor cars this graph also includes total gasoline consumption and demonstrates how closely the two are connected.

Consumption of gasoline by aviation, which for the purpose of this study can be neglected, will no doubt occupy a more predominant place in the future.

To obtain a more definite picture of the possibility of world increase in automobile registrations, the United States figures, with one car per five inhabitants, have been shown in the graph separate to the rest of the world, where the ratio is one car per 170 of population. United States share in world increase of motor cars is considerably larger than that of the rest of the world.

On account of the logarithmic scale used in this graph it is distinctly seen that the rate of progress as regards the number of United States motor vehicles is not so rapid. In a survey the A.P.I. arrived at the conclusion that the number of motor cars per head in the United States will increase only very little and that, further, the total number will advance proportionately to increase of population.

It is true that, since this A.P.I. statement, motor cars in the United States increased in one year by two million, or about 7½ percent, but it is easily understood that in this respect the United States is very close to saturation point, and that the rate of progress in other countries will be larger. Considering the prosperity level of the United States it is probable that other countries will never reach the same height.



World consumption of refined petroleum products in millions of metric tons from 1913 to 1936.

As regards progress in heavy oil consumption we have already seen that this has increased more or less proportionately to crude oil output. Of the large consumers of such oils—ships, locomotives, stationary machinery, domestic users and the petroleum industry—ships take first place with an estimated annual consumption of 25,000,000 metric tons. From the chart it appears that use of oil for bunkers has considerably increased, rising from 12,500,000 tons in 1921 to 33,200,000 in 1937. In the same period the total world fleet rose from 57,300,000 net tons to 66,300,000.

From this it seems that newly-built tonnage is mainly oil-fueled and that, for the first time, such vessels comprise more than 50 percent of the world fleet. In recent years the increase has been due entirely to motor ships.

In 1935 the world's railways used 15,500,000 metric tons of heavy oil, practically all in countries where crude oil is produced. As oil-fired locomotives are in an initial stage of development, no doubt oil consumption by railways will continue to increase, but chiefly in those countries which have an oil industry of their own. Countries which have a coal industry will continue to support that for the present.

Total consumption by stationary machinery, domestic users and the petroleum industry is unknown, but as regards domestic and industrial burners a considerable increase in oil fuel consumption is especially noticeable in the United States, with between 13,000,000, and 14,000,000 metric tons in 1936.

Although world consumption of domestic oil fuel is not known, it may be assumed that the United States—in view of its method of house construction, which differs from the rest of the world—occupies a predominant position, even more striking than for other oil products.

In the petroleum industry itself total consumption and losses amount to about 25,000,000 metric tons per year and will increase more or less proportionately to crude production. Much has been done to save fuel and prevent losses, and consequently consumption (including losses) by the oil industry has been reduced from 15 percent and over to about 10 percent, notwithstanding much more intensive refining to produce more and higher quality products.

Considering the large quanity of oil which is not consumed, in the commercial sense of the word, working economy in the oil industry is still a problem of great importance and its solution may lead to the conservation of oil reserves.

Kerosene is the fuel of those who are not so wealthy and offers great possibilities from a quantitative viewpoint. Production is quite sufficient to face kerosene demand and the same applies to other products, which need not, therefore, be discussed. It is more important to consider a few of the large oil-consuming countries.

UNITED STATES: As already mentioned, the United States is by far the world's greatest oil consumer, having completely adapted itself to oil both in industry and

society. Of the world's motor cars, 30 percent are in the United States, which consumes in all 60 percent of world oil consumption.

As the saturation point of motor cars is nearly reached, no great increase in oil consumption in this respect is to be expected. Development of water power will also act as a competitor for the heavier grades of refined petroleum products. It may be said in summing up, therefore, that the steep increase of the past is no longer to be expected and will give way to a regular percentage increase only, more or less proportionate to population increase.

RUSSIA: Second in the list of major consuming countries, Russia has, owing to increasing industrialization, found itself compelled to employ domestic production. As the situation now appears, Russia will have the greatest difficulty in making oil production keep pace with consumption, which undoubtedly is likely to continue on the increase. Considering this increase in the course of past years it is not of great importance as compared with world production and Soviet annual oil consumption may be taken at 1,000,000 metric tons.

GREAT BRITAIN: Although Great Britain is the third largest oil consumer in the world and occupies first place in Western Europe, it does not consume as much in one year as the United States does in one month.

TABLE VIII

United Kingdom Imports and Consumption

(Thousands of Metric Tons)

	1929	1930	1931	1932	1933	1934	1935	1936	1937
Imports									
Crude oil	1,997	1,884	1,407	1,508	1,603	1,928	1,952	2,047	2,120
Gasoline	2,361	2,973	2,811	3,033	3,410	3,535	4,190	4,725	5,050
Other products	3,163	3,479	3,489	3,324	3,557	3,934	4,400	4,650	4,940
Refineries' output									
Gasoline	631	659	658	577	556	554	503	500 (e)	—
Other products	1,723	1,617	1,283	1,094	1,062	1,021	1,131	1,200 (e)	—
Consumption									
Gasoline	2,992	3,632	3,469	3,610	3,966	4,089	4,693	5,225	5,500 (e)
Other products (a)	4,886	5,096	4,772	4,418	4,619	4,955	5,531	5,850	6,100 (e)
Total	7,878	8,728	8,241	8,028	8,585	9,044	10,224	11,075	11,600

(a) Including a million tons delivered to foreign vessels for bunkers. (e) Estimated.

It is in sharp contrast with the United States and Russia in that, whereas the latter two countries are in a position to supply themselves and even have a more or less considerable surplus for export, Great Britain has to cover practically all its requirements by imports. Taking into consideration that Great Britain is a coal-producing country and that, moreover, of late years electricity supply has been more strongly developed, there will always remain a certain equilibrium between these two sources of energy on the one hand and oil on the other. The part oil products will play will chiefly continue to be limited to the motor car, tractor and part of the marine requirements.

Taking the gradual increase in the past as an indication, a maximum figure of 0.25 percent of world production is a safe figure for Great Britain's future increase in oil consumption. Quantities shown in Table VIII only relate to liquid oil products, and should be increased by about 500,000 metric tons for paraffin wax and bitumen. From 1932 a steady increase in consumption is noticeable.

FRANCE: Of the large consumers, France shows the most remarkable picture (Table IX). Here we have a large country which, according to imports, has gradually proceeded to import almost exclusively crude oil instead of refined products, in order to refine this domestically according to requirements.

Although alcohol admixture may also be reckoned among the principal processes in France, yet less than 10 percent of motor energy is produced by this agency.

TABLE IX

French Net Imports and Production

(Thousands of Metric Tons)

	1929	1930	1931	1932	1933	1934	1935	1936	1937(e)
Crude oil	175	460	450	985	2,799	3,971	5,312	6,006	6,060
Kerosene	208	192	172	100	55	14	ca. 29	ca. 37	ca. 70
Gasoline	1,681	2,029	2,095	2,070	1,796	976	464	514	532
Lubricating oil	246	265	211	187	160	—	—	67	68
Heavy oils						38		—	—
Gas oil	196	179	292	357	342	206	18	150	180
Fuel oils	494	497	760	545	307	ca. 14		114	300
Total	3,000	3,622	3,980	4,244	5,459	5,219	5,823	6,888	7,210
Production of crude oil	75	76	74	75	79	78	76	70	70

(e) Estimated

Since production in France, as compared with consumption, is negligible, it is evident that this country will regularly and increasingly avail itself of world production.

JAPAN: With a consumption of 4,700,000 metric tons of liquid oil products annually, Japan is practically totally dependent on other countries (Table X). It goes without saying that the ever-increasing consumption is a stimulus to the search for means of self-sufficiency.

Japan has not had much success in securing foreign oil interests, the only one being the concession in Sakhalin, which was extended at the end of 1936, and the results from this exploitation are not very great.

In Japan the usual plans for self-sufficiency —alcohol admixture, hydrogenation, etc.— are being prepared or studied. Oil consumption will increase slowly during the next few years but it may be expected that gradually considerable quantities will be available from substitutes and coal hydrogenation.

GERMANY: So far, Germany—like Great Britain, France and Japan—has been obliged to cover its requirements mostly by importation. Especially of late oil supply has been a centre of interest, as for economical and political reasons endeavors are being made to produce all motor and other fuels, lubricants, kerosene and other products within German boundaries.

After a decrease in 1931 and 1932, consumption has increased to over 4,500,000 metric tons. At the first only a small part of the consumption was a domestic product, viz., gasoline from German crude, benzole and alcohol (Table XI).

The German Government has been endeavoring to produce energy-carriers in many ways—coal and low-temperature tar hydrogenation, synthesis, and larger admixture of benzole and alcohol—and hopes in this way to produce 2,000,000 metric tons of light motor fuel annually. For the time being the balance of requirements will have to be imported but will be restricted as

TABLE X

Japanese Imports and Consumption

(Thousands of Metric Tons)

	1929	1930	1931	1932	1933	1934	1935	1936	1937 (e)
Imports									
Crude oil	416	491	531	735	878				
Fuel oil	1,060	1,065	1,110	1,311	1,333				
Gas oil	2	—	—	2	3				
Heavy oil (b)						2,583	3,192	3,500	4,100
Gasoline	222	264	311	342	362	413	446	500	500
Kerosene	124	92	73	91	59	68	74	63	100
Lubricating oil	47	41	37	34	23	24	15	60	70
Total	1,871	1,953	2,062	2,515	2,658	3,088	3,727	4,123	4,770
Production (own)									
Japan	289	298	293	240	211	220 (e)	220 (e)	290	340
Sakhalin	184	192	187	187	193	200 (e)	200 (e)	150	
Consumption									
Gasoline	366	427	535	624	660	810	1,250	1,400 (e)	
Kerosene	170	144	125	160	126	140	160	170	
Gas oil	212	198	164	191	171				
Fuel oil	1,099	1,112	1,187	1,379	1,456	1,930 (e)	2,030 (e)	2,260 (e)	
Lubricating oil	179	204	193	210	215	220	260	270	
Total	2,026	2,085	2,204	2,564	2,628	3,100 (e)	3,700 (e)	4,100 (e)	

(e) Estimated. (b) Since 1934 crude oil, fuel oil and gas oil are given as one item, "heavy oils."

much as possible, and the utmost efficiency in use of oil products will be aimed at.

All stationary machinery is to use electricity, gas or coal as the source of energy, so that all liquid fuels will be available for motor cars, aeroplanes, ships and railways. Although a decrease in oil consumption need not be anticipated for Germany, large increases may be considered as entirely precluded.

1936 Consumption and Population

	Inhabitants Millions	Consumption Total Million Metric Tons	Consumption Per 1,000 Inhabitants Metric Tons
United States	130	130	1,000
Canada	10	5.5	550
Great Britain	45	10	220
France	41	6.8	166
Russia	175	24	135
Germany	66	4	60
Japan	100	4.1	41

The United States shows a greater degree of saturation than the other countries. Only for Great Britain and France are the size and prosperity of the population of sufficient importance to warrant an increase in oil consumption being anticipated. France's endeavor is, as a matter of fact, directed toward self-sufficiency, but not to such an extent that it will not appear to a growing extent in the world market. Greater expectations may be cherished in regard to Great Britain in this respect.

In contrast, the consumption of Russia, Japan or Germany does not show any noticeable relation to size of population. Moreover, the two latter countries are making efforts in the direction of self-sufficiency.

Having considered the principal consuming units and countries, we now have data which enables us to form an opinion on future requirements of refined petroleum products. A year ago we could hardly foresee such a marked progress in production and general activity of the petroleum industry as was witnessed in 1937. Expectations in this respect have been surpassed.

For 1938 and in the near future production will still increase, but the general recession in business which set in in the second half of 1937 will not fail to exert its influence on oil industry development. Sharp decreases in total oil production are but rare phenomena. But, at any rate, the present economic situation will strongly hamper advance in the oil industry, so that increase in oil consumption will be very limited. We estimate this at 5,000,000 to 10,000,000 metric tons yearly at the most.

Tremendous additions to storage in some European and Asiatic countries have given recent consumption statistics an inaccurate appearance of rapid increase; nevertheless demand for petroleum is increasing.

Increase in consumption, combined with scarcity of present known sub-surface oil reserves, may involve price increases in the future. A portion of the higher revenue accruing from these increases will, however, have to be reserved in order to explore and work new areas.

Since we have noted at the same time that the oil industry will in future be more dependent on economic conditions, so also will a portion of the financial reserves have to be set aside as amortization, owing to the ever-decreasing economical lifetime of plants, in order that the reaction of possible future crises may be rendered less severe.

Should the discovery of new producing areas not lead to those results that are necessary for continuing to meet demand for oil products, then prices will continue to rise until a point is eventually reached at which technically possible methods of manufacturing synthetic products will be practicable from an economic point of view.

But this stage will not be reached at all rapidly. In the first place, such higher prices, by offering greater reward to the prospector, would increase the likelihood of new oil discoveries of outstanding importance. Secondly, higher prices will result in the development of deposits which cannot be worked profitably at present, and will justify the use of more elaborate production methods whereby the ultimate yield obtained from oil deposits already known will be greatly increased.

TABLE XI

German Consumption

Year	Light motor fuels from crude oil	Benzol and alcohol as motor fuel	Other liquid products from crude oil	Number of Autos × 1,000	Number inhabitants per vehicle	Own production Germany 1,000 m. tons
	(Thousands of metric tons)					
1929	1,200	500	1,420	531	118	103
1930	1,600	500	1,500	679	93	174
1931	1,500	470	1,520	611	104	229
1932	1,220	340	1,350	616	104	230
1933	1,080	400	1,600	690	94	238
1934	1,280	530	2,000	968	67	315
1935	1,400	620	2,600	1,122	59	430
1936	1,800	650	2,100	1,370	49	445
1937 (estimate)	2,000	700	2,350	—	—	454

AERIAL Exploration in Guatemala Jungles

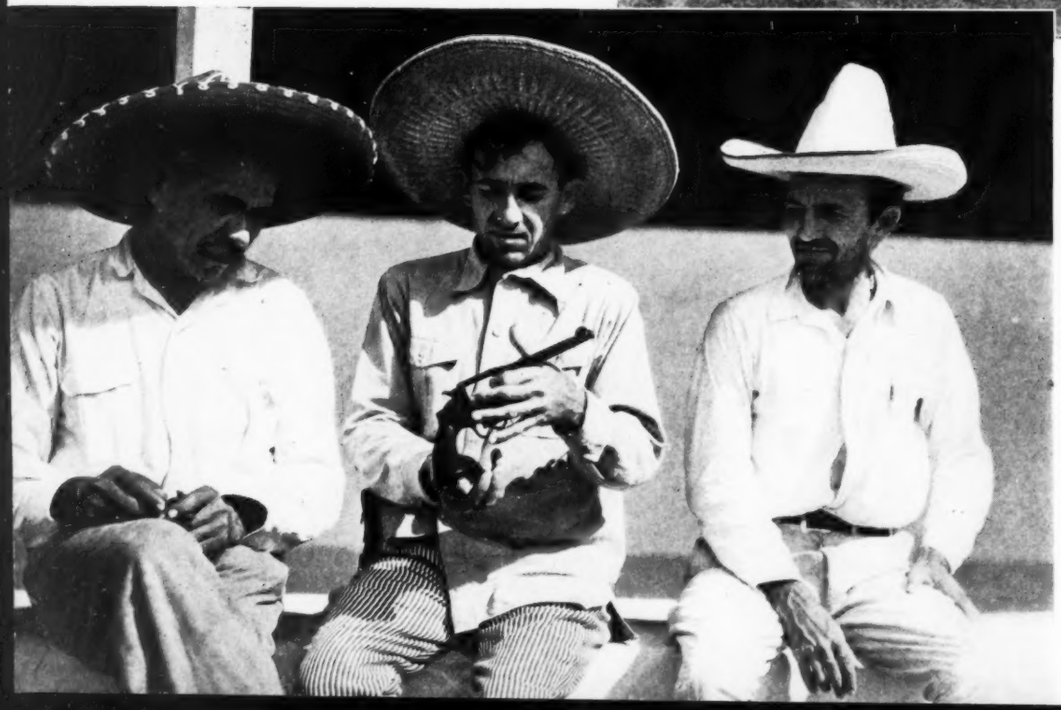
By Ralph Hancock

Improvements in the Use of Aerial Photography in Preliminary Geological Exploration and Mapping Serve to Open an Area Heretofore Considered Impenetrable.

THE ROMANCE of exploration could find no better ground for action nor material for circumstance than that offered by the wild Peten Territory of Guatemala in Central America, where the Compania Guatemalteca de Petroleo Shell (Royal Dutch Shell Group) is already well along in their preliminary geological surveys. Although Standard Oil made a tentative survey of this area some fifteen years ago and pronounced its prospects impractical, the new improvements in geological survey methods with the help of aerial photographs has encouraged Shell to undertake the present project.

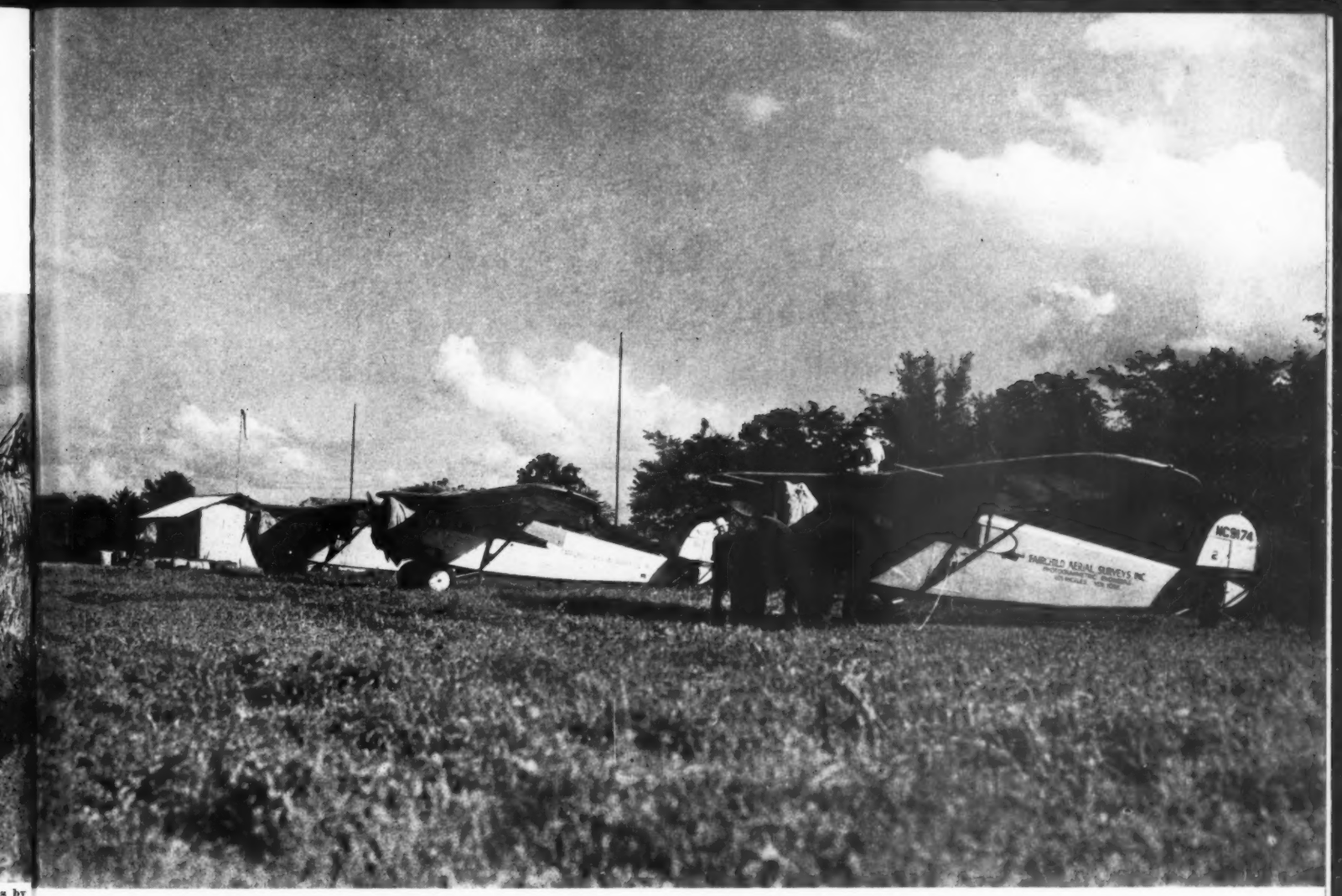
Photos by Frank Neubauer

Below—Chicle gatherers, or Chicleros, of Central America. Their knowledge of the Peten and years of experience in the jungle made them invaluable as guides for Shell's first geological expedition in Guatemala. Right—The City of Paso Caballos (Pass of Horses), so named by the ancient Mayans when they first saw men on horseback, is the last outpost of Fairchild's jungle air operations, and the base for Shell's geological expeditions. Above—Paso Caballos landing field. Similar fields will be constructed near points of exploitation, as this is the only means of transportation in the Peten.



Offices were opened in Guatemala City in June, 1937, with Mr. Roy W. Merritt, in charge and a staff of Shell geologists gathered from every corner of the globe. Rights for exploration cover a two year period but officials of the local company are confident that within that period selections for exploitation will be made.

The first step in the Guatemalan job will be to complete a thorough aerial survey of



Camera-equipped planes of the Fairchild Aerial Surveys, Inc., lined up on a jungle airfield in the Guatemala Peten in preparation for their job of photographing 17,000 square miles of possible oil territory.

the entire Peten area, a total of some 17,000 square miles of unexplored, wild jungle country. Contracts for this work were let to the Fairchild Company who took the first pictures on December 14th, 1937.

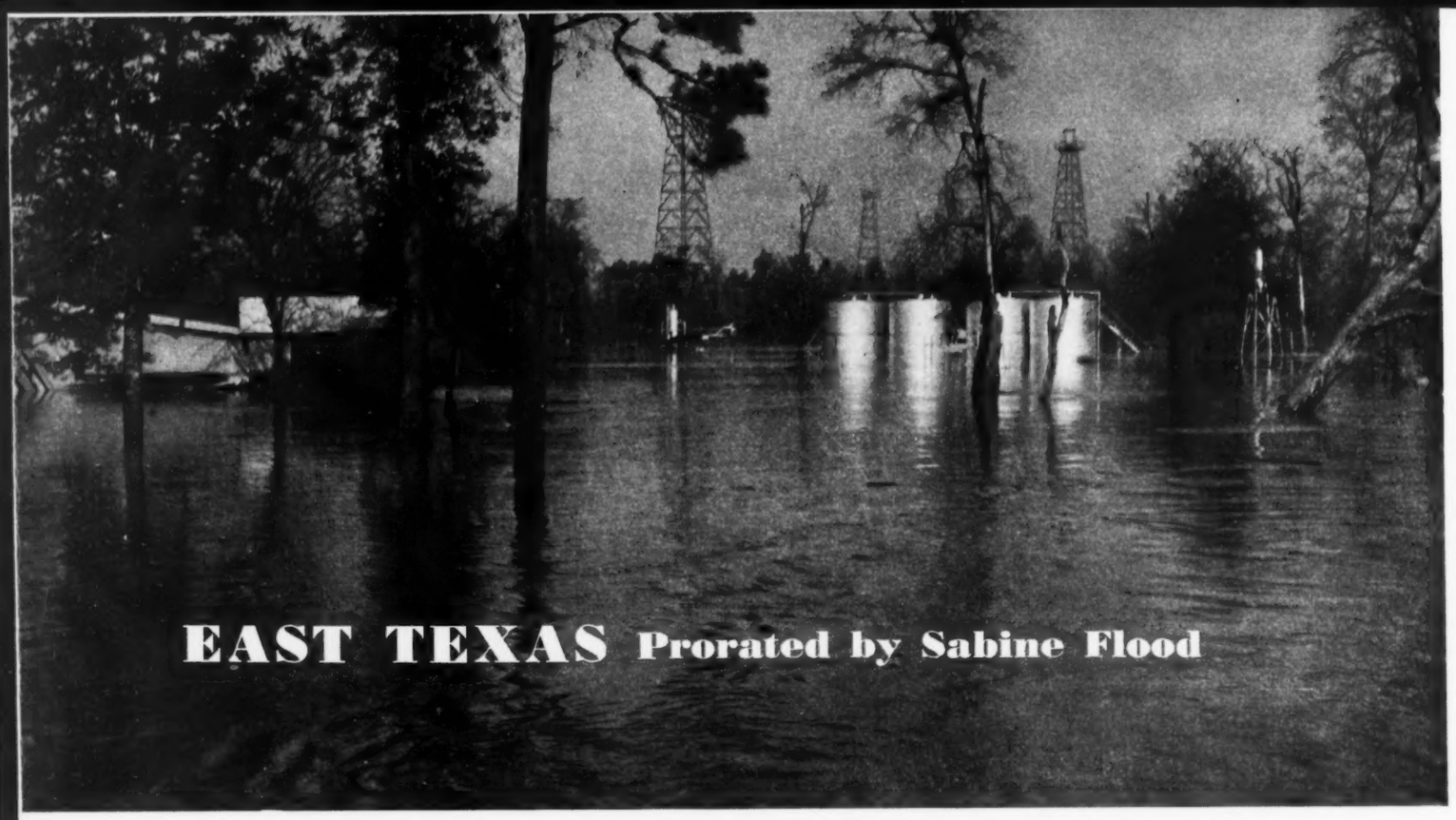
Three Fairchild planes, one of them the famous high winged monoplane STARS AND STRIPES used on the Byrd Polar Expeditions, and several of the latest in Fairchild nine by nine inch single lens, wide angle cameras, a complete laboratory, and other equipment for the necessary ground work in connection with aerial photography, is in operation in Guatemala. Subsidiary landing fields have been established at Paso Caballos, Flores, and La Libertad, deep in the heart of the jungles. Astronomical points are being established by ground explorers in various parts of the Peten, and when these are completed no other ground control will be needed in laying out the immense jig-saw puzzle of over 3,000 photographs, according to Mr. E. R. Polley, Vice President of Fairchild, who is in the Guatemala field. The method of final assembly as perfected by Fairchild and known as the "slotted template method," is undoubtedly the most accurate map making method so far invented. All of the pictures are being shot from 2200 ft. and will be reduced to the final map on a scale of 1:40,000.

Mr. W. B. Wisenand, whose geological explorations in the Rockies attracted some attention last year, is conducting the difficult ground survey work in locating the astronomical points for ground control in laying out the photographs.

As soon as the huge map is completed and studied, Shell's field geologists will start their ground expeditions into the Peten. What this map will uncover, or what mysteries besides oil, the explorers will uncover, one can only guess. The Carnegie Institute's Mayan explorations have uncovered sufficient evidence to indicate that the Peten has within its impenetrable jungles countless buried cities comprising an empire that at one time was greater and stronger than Egypt in its prime. The Peten is undoubtedly the largest and wildest unexplored area on the North American Continent. Most of the chicle used in the manufacture of chewing gum comes from this area, and the Chicleros, that heterogeneous breed of swashbuckling cutthroats, are practically its only inhabitants.

Following up on the selections made by the exploration crews will entail other difficult work. In view of the tremendous obstacles to overland transportation all machinery will probably be hauled in by plane. This will necessitate the clearing and construction of landing fields and confine such operations to favorable weather conditions. However, since all the chicle gathered in the Peten is brought out by plane, at the rate of several tons per day during the season, the oil officials are profiting by this experience.

Although parts of the Peten greatly resemble some of the oil locations in Mexico, Venezuela, and northern Colombia, officials in charge of the Guatemalan field work state that they will not even guess at the specific grade of oil, possible quantities, or estimate drilling costs, at least not until after the ground surveys and field explorations are complete, but indicated that they had reason to feel confident that whatever it cost the Peten would eventually be a profitable field.



EAST TEXAS Prorated by Sabine Flood

Trees mark the normal river banks while lease tanks and derricks stand well back from the river. These and other tanks were pumped dry of oil and filled with river water in anticipation of the rise.

CURTAILED not only by state regulation of the flow from their wells, many operators in the East Texas field also face occasional proration by a force which admits of no evasions or hot oil flowing—the Sabine River, which winds a thirty-mile channel through the center of the field, and which has twice this year inundated many leases and restricted or entirly cut off production.

In the earlier flood the rise and subsidence of the river was comparatively rapid, some of the drowned wells being off flow only two or three days, but with the second flood of the year, coming in the wake of the first, the rise was rapid, and the high stage protracted. Estimates of lost time in the second flood only, which reached a stage two feet higher than its predecessor, show a total of 1,156 wells which could not be flowed regularly, the shutdown time ranging from two days at flood crest to as many weeks in other sections. Estimates based on figures assembled from representative producers place the enforced river shutdown as 10,404 well-days, or on the basis of minimum allowable, a loss of 208,080 bbl. of oil due solely to flooded wells.

To the figure of production loss due to inability to reach wells there must be added the additional time required to service the power units, reduction gears and other well equipment flooded or otherwise put out of commission by the high waters. Estimating, again, as it will be months before all figures can be assembled and placed before the Railroad Commission in an attempt to secure back allowables, there will be a further shutdown of 3,251 well-days, or an additional loss of production totalling 65,020 bbl.

On a basis of lost production alone, the second of the 1938 floods costs the producers upwards of $250,000 in revenue from production, with the estimated figures of 273,100 bbl. under rather than over the probable final total. These estimates are on a six-day basis, the field being shut in on Commission order on Sundays at the time.

Added to the loss of production, which falls alike on lease holder and property owner, there is a stupendous repair bill facing many producers before they can again resume normal flowing. Of the 493 pumping wells reported submerged, both prime mover and reduction gear must be dismantled, thoroughly cleaned of silt and water, reassembled and refilled with new lubricant. At a minimum figure of $25.00 per unit, this reaches $12,000, for labor and oils alone, to which must be added the cost of resetting many batteries of lease tanks, the resetting of seven derricks toppled or sagging so seriously as to require rebuilding, the regrading of more than 15 miles of field and lease roads washed out by the stream as it spread from a normal width of a few yards to as much as one and a quarter miles, rebuilding of fire-walls and earthen storage pits and the removal of debris from around wells and lease equipment.

With many of the lower roads still blanketed by the muddy waters, complete material damage is still problematical, but figures now total around $1,000,000 needed to restore the river bottom section to its former well-kept condition.

A battery of low 500's, later lifted from their beds despite being oil-filled, in a site normally a mile from the channel.

Tank farms such as the Atlantic and Magnolia, located adjacent to the river bed, were closed down during the peak of the flood, with water reaching as high as the second ring of many 55 ft. tanks and making access to control valves impossible.

Field gathering stations located in the bottoms were drowned out, one company, Tidewater Associated, planning to remove its low-lying stations to higher ground as result of lost pumping. Another field pump station, normally three quarters of a mile from the river channel, saw the crest halt only a few inches below hastily sand-bagged fire walls, with an auxiliary station just below it stripped of motors and controls to escape the flood.

The flood threatened earthen storage pits impounding over 100,000 bbl. of illegally produced crude, confiscated by the state and held for auction. One such reservoir, containing an estimated 20,000 bbl. was overflowed despite frantic sandbagging of weak spots, but the "oil" failed to float away. The original 40 gravity crude had so weathered that it was in effect but a vast mass of paraffin and "b.s.", and would have floated only in much warmer water.

River-bed switchers and their families were evacuated without loss, but two lives were claimed as a result of oil-filled flood activities.

One well, long on the pump, was converted, during flood duration, into a flowing well when the derrick shifted, taking with it a rip-rap wooden floor which cracked the Christmas tree and released a steady stream of oil which found its way through the waters to spread in a thin scum smoothing the ripples and waves for a long distance down stream.

As yet the Railroad Commission has made no move looking toward the making up of allowables lost by flood conditions, the question having come up in connection with the earlier inundation, and being intensified by the second, deeper and more enduring flood. In the absence of any definite decision, the Commission's attitude seems to favor classing such a flood-enforced prorating of the affected wells as it does shutdowns occasioned by failure of the human or mechanical element at the individual well.

With many of the wells at the upstream end of the inundated area already pumpers, and producing in some instances up to 80 percent salt water it is regarded as doubtful if all former production is ever reestablished after the enforced shutdown. Where these wells which go dead lie on leases having other wells more fortunately situated with regard to water encroachment, it is natural to conclude that somehow the discrepancy will be made up as opportunity permits, but for the small producer the flood and its results may spell failure and bankruptcy.

Lease tenders go Venetian as row boats and canoes replace the trusty model T and later cars for transportation. This crevasse (below), through a 12-foot levee, flooded 8,000 acres and cut off the Selby Oil camp except by boat.

One-well lease threatened with extinction as pumping equipment is drowned and tanks begin to bob in the current—ripples beyond the lower tank betray the ridgepole of a pumping station, normally 12 feet above its foundation.

BRITISH Price Cut Reflects Lower Gulf Prices

By Alec H. Day

REDUCTION of British motor spirit prices by ½d. per gallon, bringing first-grade spirit down to 1s. 6½d., gave definite expression to a weaker market tendency. Attention was drawn to the downward trend of the British price structure in the December 1937 issue of WORLD PETROLEUM. Actual cuts in quotations would have come earlier but for the rise in Gulf-U.K. clean tanker freights from 22s. to over 30s. during the closing weeks of last year.

On the basis of Gulf motor spirit quotations, a lower price level in Britain might have been decided on some weeks ago. Reasons for the delay are two-fold. In the first place, the national distributing companies wished for time to observe the market's reactions to the recent adjustment in retailer's margins on spirit sold through pumps. Secondly, the tanker freight market has been showing a considerable lack of balance. Instability and a rising trend marked tanker freights at the close of last year and the beginning of 1938. This combined with the possibility then envisaged of a reduction in motor spirit quotations by the big distributors, was a discouragement to independent shipments.

Freights have now been relatively stable at a high level for some weeks. Decline of Gulf motor spirit prices has persisted, and sterling cost of shipments has been further reduced to a small extent by the decline in the exchange value of the U. S. dollar.

Operation of these factors was evidently making the market too attractive to outside shipments to accord with the policy of the national companies. A reduction in prices was thus the logical method of restoring the balance between costs and selling prices.

Gulf quotations in July, prior to the last reduction in British motor spirit quotations, were equivalent to fully 1d. per gallon in sterling above those now ruling. Although freight costs, which had fallen considerably in the autumn, have recovered to something not far short of their July figure, there is little chance of a further rise sufficient to offset the weakness of Gulf prices.

Insurance, landing charges, evaporation and other costs have not shown sufficient change since July to affect laid-down costs.

Cost of 64/66-375 E. P. Spirit Delivered in England

(Sterling per Imperial Gallon)

	July 1937	October 1937	February 1938
Gulf Price	3.6 d.	3.4 d.	2.4 d.
Freight, Etc.	1.3 d.	1.0 d.	1.3 d.
Import Duty	8.0 d.	8.0 d.	8.0 d.
Total Cost	12.9 d.	12.4 d.	11.7 d.

These figures, it should be emphasized, bear no relation to the actual costs incurred by distributing companies before the spirit is sold to the consumer. Aside from the question of the high-quality spirit actually retailed in Britain, overheads and retailers' margins have to be provided from the difference between costs and selling prices.

Comparison of the laid-down figure with the price to the consumer should also take account of the fact that the 1s. 6½d. now ruling for first-grade spirit applies only to the relatively small volume of spirit sold to the private motorist. The great bulk of the trade is in commercial grades, the standard price of which is now 1s. 4½d., while a very large part of the total turnover of British distributing companies consists of contract business at a still lower range.

With the cut now announced, standard prices in the British market have been reduced to a figure below that of a year ago.

British Motor Spirit Price Changes Since 1931

Date	Price Excluding Duty d.	Duty d.	Total s.	Total d.
March 3, 1931	10½	4	1	2½
April 28, 1931	10½	6	1	4½
May 22, 1931	9½	6	1	3½
July 18, 1931	8½	6	1	2½
September 10, 1931	8½	8	1	4½
September 14, 1932	11½	8	1	7½
May 17, 1933	9	8	1	5
November 3, 1933	10	8	1	6
March 29, 1934	9	8	1	5
May 1, 1935	10	8	1	6
January 13, 1937	10½	8	1	6½
February 11, 1937	11	8	1	7
April 26, 1937	11½	8	1	7½
July 29, 1937	11	8	1	7
February 18, 1938	10½	8	1	6½

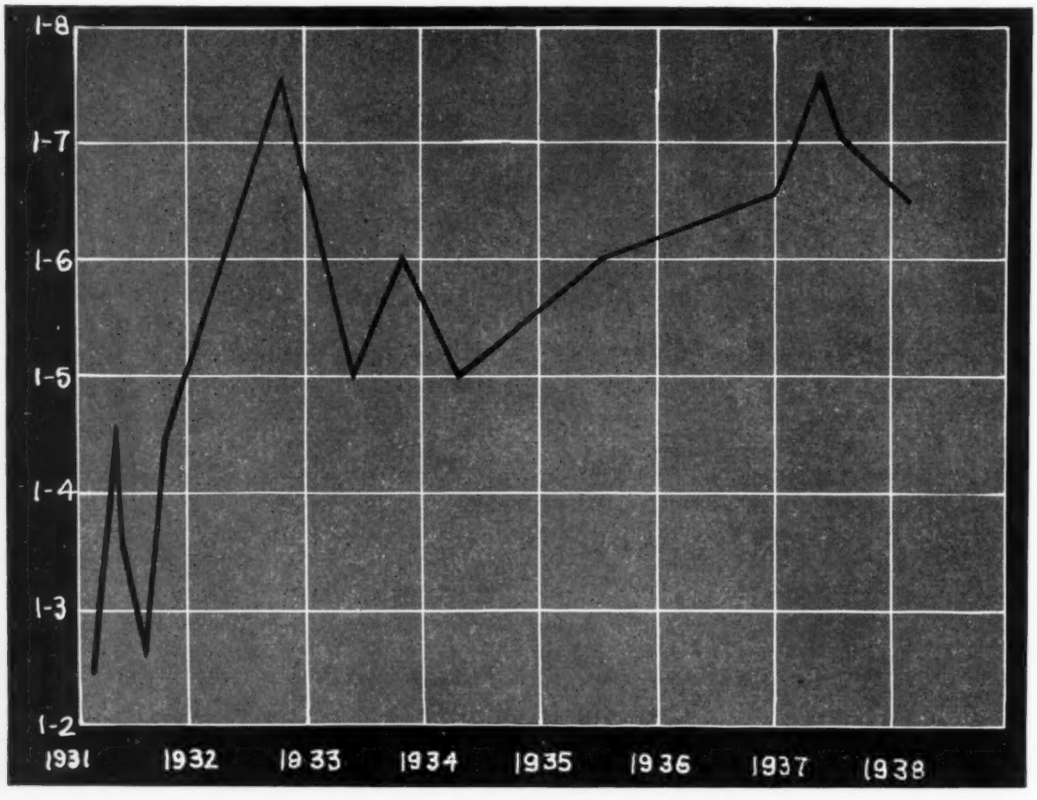
A notable feature of fluctuations during 1937 is the response shown by motor spirit prices to the general fluctuation in commodity values. The commodity boom developed most strongly in the spring, prices also reaching their apex around April.

Higher motor spirit quotations last April were largely the result of the pronounced advance in tanker freights, part of a general rise in freights due to the demand for commodities. Otherwise no connection can be established between fluctuations during 1937 in motor spirit and other prices.

Price movements in all petroleum products showed relatively small variations in 1937 compared with practically all other commodities. Reasons for this stability are to be found in the success of co-operation in the United States to keep production somewhere within sight of demand, and the strong consortium of integrated companies in oil distributing markets.

Control at both ends of the oil industry has eliminated speculation, which was mainly responsible for last year's wide price fluctuations in other commodities.

This stability is likely to be maintained in Britain. The policy of the national group is evidently unaltered. It consists of keeping selling prices in close conformity with the trend of world prices, the object being to maintain the existing balance of distribution and discourage fresh entrants into the market.



Graphic representation of price fluctuations (shillings and pence per Imperial gallon) on the British gasoline market, 1931-1938.

INTERNATIONAL NEWS

TWENTY-ONE leading British oil companies produced and refined 31,776,198 tons of crude oil during 1937.

TWO of the twelve naval-type tankers building for Jersey Standard under agreement with the U.S. Maritime Commission have been allocated to Keystone Tankship Corporation of Philadelphia. These will be among the first four of the program completed.

J. W. VAN DYKE, Chairman of Atlantic Refining states that: "The company is continuing the policy of making substantial expenditures during 1938 for property, plant and equipment that promise to bring operations into better balance and reduce cost.

SOUTH African Torbanite Mining and Refining Company Ltd. has admitted that, with the present capacity of its new retorts, it is not possible to produce motor fuel from torbanite shale profitably at the present price level. By refining imported crude oil the company is making a profit, and this counterbalances the cost of treating torbanite.

GULF Exploration Company (Great Britain) Ltd. will shortly commence drilling at Penshurst, near Tunbridge Wells, England. Meanwhile, the company has been granted five additional oil prospecting licenses covering 669 sq. mi. in Yorkshire and Lancashire by the British Department of Mines. Two further licenses over 249 sq. mi. in Southampton and Sussex have been granted to D'Arcy Exploration Company Ltd. (Anglo-Iranian). England is now 26.4 percent under exploration permits.

ABOUT $4,480,000 will be spent on exploration work during 1938 by Nederlandsche Niewe Guinea Petroleum Maats. (owned 40 percent by Royal Dutch-Shell, 40 percent by Jersey Standard and 20 percent by California-Texas interests). The company has already spent about $3,360,000 in surveying its 10,000,000 hectare concession in Netherland New Guinea and some 30 geologists are busy selecting sites for drilling, which soon will be commenced.

GERMAN DISCOVERY

CONSIDERABLE importance is attached to No. 3 well in the Bergedorf field, Germany, which came in at 2,280 ft. Geological studies had not predicted oil for another 60 ft. There was no existing tankage or pipeline to enable a test to be made, but it is possible that it will run from 700 to 1,000 bbl. daily.

U. S. RESERVES

PETROLEUM reserves in the United States are estimated at 15,507,268,000 bbl. by the Committee on Petroleum Reserves of the American Petroleum Institute. While this figure represents a new high for U.S. reserves, it should be noted that following publication of the Committee's report for reserves on January 1st, 1937, given originally as 13,063,400,000, it was found necessary to add to that figure the amount of 2,792,790,000 bbl. making total reserves as of January 1st, 1937, 15,856,190,000 bbl. So the current report indicates that production in the United States has exceeded additions to reserves by not less than 348,922,000 bbl. The Committee on Petroleum Reserves is comprised of geologists and engineers and its estimates are based on work that is the result of cooperation between members of the committee and over 100 experts in various parts of the country.

Texas reserves at 8,247,928,000 bbl. are the largest of any state. California was the second largest reserve and Oklahoma is third.

BRANTLY HANDBOOK IN 2nd EDITION

THE second edition of J. E. Brantly's ROTARY DRILLING HANDBOOK came from the press early in February. Containing 48 more pages than the first edition, the new volume brings up-to-date all of the text material contained in the earlier volume and in addition contains 50 pages of new tables, half of which are entirely original. All are designed to solve any practical problem arising in the drilling of an oil well.

Mr. Brantly wrote his Handbook particularly for the practical man in the field, a fact which has been important in giving the volume a very wide appeal. The book has chapters devoted to derricks, power plants, engines and drawworks, rotary tables, feed controls, fishing, casing and cementing, formation testing and hole sizes. There is also a chapter on geology in which the author sets forth briefly certain fundamentals that should be part of the knowledge of the man engaged in drilling.

Readers of the first edition know that Brantly discusses present day drilling equipment freely, and where he believes there is room for improvement does not hesitate to be critical. Strictly technical matter does not appear in the volume; but on the other hand, simple and obvious operations and methods have likewise been eliminated. Many illustrations appear throughout the text.

J. E. Brantly, the author, is a practical oil man of many years' experience, and is president of Drilling and Exploration Company, drilling contractors with world-wide operations. He has a thorough first-hand knowledge of every phase of rotary drilling and from his experience writes of his subject in a way calculated to give the reader practical information.

ROTARY DRILLING HANDBOOK is published by Russell Palmer, publisher of WORLD PETROLEUM and PETROLEUM WORLD. It is on sale for $3.50 at the Home Office, 95 River Street, Hoboken, N. J.; in London at 3 Savoy Place, Victoria Embankment, W.C.2; and at the offices of PETROLEUM WORLD, 412 West 6th Street, Los Angeles.

Grand prize winner in the First Annual Poster Contest for modern art designed by Miss Fernanda Zogni. The contest was held in New York on February 4, sponsored by Ryan, Leach and Goode for Shell of Canada.

Foreign Oil Legion

Ibn Taimur and Cordell Hull

SAIYID SAID IBN TAIMUR, Sultan of Oman, who is on a trip around the world, arrived in Washington, D.C., on March 3rd for an official visit of three days. The Sultan was accompanied by his secretary, A. H. ZAWAWI, and H. B. BADER, his aide-de-camp. Secretary of State CORDELL HULL formally received the distinguished oriental visitor, and among those accompanying him were ADMIRAL WM. D. LEAHY, chief of Naval Operations; MAJOR GEN. THOS. HOLCOMB, commandant of the Marine Corps; WALLACE MURRAY, chief of the Near Eastern Division of the State Department; and BRIG. GEN. DANA T. MERRILL, commander of the Washington provisional brigade. Ibn Taimur later visited the Federal Bureau of Investigation to study methods of crime detection—a subject which has always greatly interested him. He had lunch with PRESIDENT ROOSEVELT and dinner with Mr. Hull. The Sultan had already been in America incognito for three weeks, as Mr. Said. Aged 27 years, he is ruler of about 500,000 people and 82,000 sq. mi. in the southeastern corner of Arabia, where are bred the best camels. His sultanate, with the capitol at Muscat, is one of the territories being oil explored by Petroleum Concessions Ltd. (Iraq Petroleum Company group) through its subsidiary, Petroleum Development (Oman and Dhofar) Ltd.

ROBERT F. HAND, assistant general manager of the marine department of Standard Oil Company (New Jersey), left New York March 3rd on board the ss JAMAICA en route to Cartagena, Colombia, and other Carribean ports. The trip is essentially a vacation from the arduous work involved with the management of one of the two world's largest privately-owned tank shipping fleets.

Shell's laboratory, department of photography in charge of Fairchild Aerial Surveys, Inc., in Guatemala City. Frank Neubauer, chief laboratory technician, is in front of the building (see story on pages 54 and 55).

JAMES A. MOFFETT, chairman of the board, California-Texas Oil Company, Ltd., is at present on a tour through Africa and Asia. He originally passed through London traveling by boat to Cape Town and thence to Johannesburg and Durban. From the latter port Mr. Moffett embarked for Bombay, India; and while in that country visited Ara, Delhi and Japur. He took a ship from Bombay to the Bahrein Islands and expects to return to India during the first week of April, and proceed to New York early in May. Mr. Moffett will also visit Egypt.

AXEL GRONBECK, European representative of the Lummus Company in London, sailed from New York on board the QUEEN MARY March 9th after an extensive trip through the United States on company business. His firm has just concluded a contract from Compagnie Francaise de Raffinage for a 15,000 bbl. capacity visbreaking plant. The current business recession in America has no counterpart in Europe, said Mr. Gronbeck. The engineering industry is active and prosperous not only due to the vast armament programs under way in practically every country on the continent, but due also in large measure to the large refinery and other construction programs which are being carried out by the oil companies, local and international.

FRANCISCO RAPALLINI, manager of the Plaza Huincul oilfield of Yacimientos Petroliferos Fiscales (Argentine Government Oilfields), and his assistant, SOCRATES BROULLON, of the production department in Buenos Aires, are visiting the United States for the purpose of studying latest American drilling and production techniques. At present they are in Los Angeles, but will later proceed to East Texas and the Mid-Continent.

B. F. BASKIN, of Los Angeles, arrived at Teheran, Iran, February 6th, where he will act as transportation manager for Amiranian Oil Company.

G. J. BAKER, K. THEODORE TAGGERT, SAMUEL E. MCDONALD, LESLIE B. RICHARDSON, and C. P. MACDONALD sailed from the United States on board the ss LINDENFELS February 7th with the first shipment of drilling machinery for Amiranian Oil Company. The first test well is expected to be commenced early this summer.

W. D. KUNZE, formerly with Standard Oil Company of Venezuela in the Maracaibo Lake Basin fields and for the last two years in West Texas, sailed from New York late in February for Cucuta, Colombia, where he will be a driller on the Barco Concession. HOBERT CREATH, of California, followed him to Cucuta early in March.

Kenneth R. Parsons

GORDON L. POSTLE, of Butte, Montana, and KENNETH R. PARSONS, of Chicago, Illinois, sailed from New York March 5th en route to Kabul, Afghanistan, where they will be conducting geological surveys for Inland Exploration Company. Their address will be care of Inland Exploration Company, Kabul.

Gordon L. Postle

Thomas Ward, reading the newspaper, during a trip on the Houston Ship Canal last October—seated centrally, also coatless, is J. A. de Lanoy, chief purchasing agent for the Asiatic Petroleum and Anglo-Mexican Petroleum Corporations.

THOMAS E. WARD, president of Oilfield Equipment Company, left New York early in March for a three or four week visit to the oilfields of Trinidad and Venezuela. In the course of his trip he hopes to connect with J. H. MCEVOY, president of J. H. McEvoy Company, at Port of Spain, Trinidad, on the latter's return from Venezuela.

MARTIN HESS, with Mrs. Hess, is at present in California after spending several years in Venezuela as drilling superintendent for British Controlled Oilfields Ltd.

MILTON LEWIS, leading refinery sales representative, who began an active carerr nine years ago at Southwestern Engineering Company, has severed connections which grew out of this original affiliation to join the Fluor Corporation. Meeting refiners and natural gasoline men, Lewis built up a reputation that led to his appointment by RALPH M. PARSONS, as West Coast sales representative, while still affiliated with Southwestern. While in Parsons' employ Mr. Lewis assisted in the sale of some $3,700,000 worth of business. He will now specialize in cracking plants, general refining processes, construction, and sale of equipment manufactured by the Fluor Corporation.

BEDFORD SHARP, of Mission Manufacturing Company in Houston, sailed from San Francisco on February 12th for a two months' rest in Hawaii. Mrs. Sharp accompanied him. They have taken a cottage at the back of the island and intend to lead the simple out-door life during their stay there.

BOB BRADFORD, who makes his headquarters at San Fernando, will soon be leaving Trinidad by air en route to Peru, Ecuador and Colombia on behalf of the companies represented by I. FRANK BROWN. He will visit all oilfields, including those of International Petroleum Company, Lobitos Oilfields Ltd. and Cia. de Petroleo Ganzo Azul (Blue Goose Oil Company) in Peru; Anglo-Ecuadorian Oilfields Ltd. and Ecuador Oilfields Ltd. in Ecuador; and Tropical Oil Company, Colombian Petroleum Company, The Texas Corporation and Socony-Vacuum in Colombia.

DR. J. V. PENNINGTON, of the Reed Roller Bit Company, has recently been given the title of director of manufacturing. He will no longer be as closely associated with the sales division, though with other increasing responsibilities now has charge of plant inventories.

WORLD PETROLEUM ABSTRACTS

Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing With Technical and Economic Aspects of the Petroleum Industry. Edited by Dr. O. W. Willcox

GEOLOGY

Oriskany Explorations in Pennsylvania and New York—S. M. Hamilton, in BULL. AM. ASSOC. PETROLEUM GEOLOGISTS, vol. 21 (1937), No. 12, pp. 1582-1591.

The author has developed what might be considered a new criterion for the possible location of oil in the Oriskany. This criterion is indicated from a study of natural gases found in Oriskany structures. It appears that starting from the mountain front near the Sabinsville anticline in Tioga County, Pa., and proceeding in a northwesterly direction the percentage of methane in the natural gases of the region diminishes from 99.5 to 84 percent in the vicinity of the Allen anticline in Allegany County, N. Y. That is to say, the more remote from the mountain front metamorphism the richer the natural gas in the heavier components ethane, propane, butane, etc.

The explanation offered for this state of affairs is that any original oil deposits or gas accumulations in the vicinity of active metamorphism must have been subjected to considerable heat, with the result that the gaseous hydrocarbon having the greatest stability, in this case methane, would be the principal survivor. In horizons farther removed from the zone of metamorphism, larger proportions of the heavier hydrocarbons would appear in the residual gas. Still farther away the heat would not be sufficient to decompose liquid oil deposits.

The implication is that where the natural gas in the rocks consists exclusively or predominately of methane the chances of finding oil may be discounted whereas the prospect is somewhat brighter if some of the heavier gases are also present.

The relations here shown have a noticeable analogy with the carbon-ratio theory of oil probabilities according to which oil is most likely to be found in certain localities where the coals of the region contain a high percentage of volatile matter; oil is less likely to be found where volatile matter of coal is low, this being a sign of metamorphic activity that would destroy or expel petroleum from the rocks.

The Medina and the Trenton of Western New York—Chris A. Hartnagel, in BULL. AM. ASSOC. PETROLEUM GEOLOGISTS, vol. 22 (1938), No. 1, pp. 79-99.

The Medina (Silurian) and the Trenton (Ordovician) formations of New York are well known members of the Lower Paleozoic system. Two divisions of the Medina are recognized, the upper, known as the Albion sandstone, being the source of most of the Medina gas. The most prolific Medina fields are in the countries bordering Lake Erie. The fields are slow yielding of their gas and have a long life.

The Trenton formation is predominantly a limestone but contains numerous beds of shale. Gas may be found at many horizons in a single well and large pockets of gas are commonly encountered. Small but persistent flows have been maintained in several shallow pools near the east end of Lake Ontario for more than 35 years. Deep tests of the Trenton in other parts of the state have failed to yield outstanding results.

From experience gained by drilling operations during the past 40 years, it is evident that there is little hope of developing a large gas field in the relatively shallow territory near the eastern end of Lake Ontario. The best that can be expected is the development of small community fields from which the entire output of gas can be consumed locally. In other sections of New York, where the Trenton is found under a deep cover of rock, some tests have been made, but the results have been disappointing. It must be admitted, to be sure, that much of western New York remains untested, but on the basis of results obtained in the fields already developed, the prospects for finding an important gas field in the deep Trenton of western New York are not encouraging.

GEOPHYSICS

Gravimeter Design and Operation—A. B. Bryan, in GEOPHYSICS, vol. 2 (1937), No. 4, pp. 301-308.

An elementary general discussion of gravimeters and a brief comparison of gravimeter with torsion balance are given. Details as to construction, accuracy, speed of operation and methods of making field observations are given for one type of instrument which is being widely used in geophysical exploration work.

Determination of Geo-Mechanical Properties of Well Cores in the Laboratory—H. J. Schoene, in OEL UND KOHLE, vol. 13 (1937), No. 44, pp. 1079-1082.

In connection with the geophysical survey now in progress in Germany a study has been made of the geo-mechanical properties of a large number of well cores, taken mostly from the upper Cretaceous through a section of 6,088 ft. The cores are examined for elastic behavior, velocity of longitudinal waves, volumetric density, specific gravity, and true and apparent porosities of the sedimentary rocks.

The curves of the elasticity modulus and those of the velocity of longitudinal waves show a pronounced parallelism. The data found are in agreement with the results of seismic investigations. The curves of volumetric densities show a very marked increase of density with depth in this petrographically rather uniform geological section, whereas there is very little variation in true specific gravity. The varying calcium carbonate content of the cores has a marked influence on the elasticity modulus.

A New Source of Damped Wave Trains Suitable for Testing Geophysics Apparatus—D. G. C. Hare, in GEOPHYSICS, vol. 2 (1937), No. 4, pp. 309-318.

A newly developed electric circuit is described by means of which electrical transients of nearly any desired characteristics may be conveniently produced. The circuit is particularly adapted for use with a cathode ray oscilloscope, in that no auxiliary synchronization is necessary. A typical use in the testing of geophysical circuit elements is illustrated, and a novel method of making rough phase-shift measurements is described.

Seismic Electric Prospecting—A. Belluigi, in OIL WEEKLY, vol. 87 (1937), No. 12, pp. 38-42.

The author discusses what now has the promise of a new method of studying underground structures. It depends, in principle, on the fact that if a direct current is sent into the ground by means of a two-electrode arrangement and if artificial seismic waves are produced by explosions or the shocks of falling bodies, electrical measurements made at the time will show oscillations that when recorded, can be compared to a real seismogram. The author has made various experiments on the matter and suggests a layout of equipment for applying the principle to geophysical exploration.

Mapping Faults by Reflection Method—Henry Salvatori in GEOPHYSICS, vol. 2 (1937) No. 4, pp. 342-363.

In regions where reflections can be correlated from point to point the mapping of faults presents little difficulty, and the hade as well as the throw of a fault can be generally determined. Two records secured across a fault are reproduced and a cross section derived from these records is shown. A description is given of a method of profiling which permits correlation of records in areas where the ordinary correlation method cannot be successfully applied. The application of this method in the determination of faults is outlined.

DRILLING

Connate Water in Oil and Gas Sands—Ralph J. Schilthuis, in PETROLEUM TECHNOLOGY, vol. 1 (1938), No. 1, T.P. 869; 14 pages.

This paper emphasizes the necessity of taking account of the native or connate water occurring in oil and gas sands. It is generally agreed that migration and accumulation of oil has occurred in porous formations that were saturated with the salt water of ancient seas, and that the displacement of this water from the pores by the migrating gas or oil is hardly complete. Hence the amount of oil or gas in the formation will not be accurately known from a mere determination of porosity of core samples unless the volume of the connate water in the pores is also known.

This means that cores should be taken under conditions that will allow an estimation of the quantity of connate water in the cores. The trouble here is that when a water-mud is used in drilling some of the water of the mud may get into the cores and thus complicate matters. To get around this difficulty an oil-base drilling fluid prepared from the native crude oils weighted with oil-wet clay has been employed in coring the gas and oil zones of the Anahuac and Tomball fields, in the Texas Gulf Coast area, and in the East Texas field. The weighting material was spent clay, which had been used in the refining of motor oils. The fluid was treated with about 0.5 percent of oleic acid and one percent of sulphuric acid (98 percent), by volume, to aid dispersion of the clay and to increase the tolerance to water. Litharge was used where necessary to increase the mud density. The oil used as mud-fluid may complicate the determination of oil in the core, but will practically assure accuracy in the connate water determination. The author describes an appropriate technique for the analysis.

Results by this procedure show connate water contents in wells of the East Texas field ranging from six up to 30 percent. In the Anahuac and Tomball fields percentages from 16 up to 98 percent of the pore volume were noted.

The importance of this is that connate water directly affects percentage of oil saturation of the sand. Sands having identical permeability may contain widely different quantities of oil. The difference is due to variance in other properties of the reservoir rock and in the properties of the fluids involved. The fact that for the same porosity there may often be a marked variation in oil saturation has an important bearing upon reserves and recovery of oil. It is common practice to base estimates of oil recoveries purely upon acre-foot yields experienced in fields considered similar to that on which the estimate is made. Without the aid of more information than is usually at hand, this is likely to be a dangerous procedure. Two fields may differ only slightly in operating characteristics in early life but may have distinctly different unit oil saturations and thus may yield entirely different unit ultimate recoveries. (See also following abstract—Ed).

Influence of Connate Water on Permeability of Sands to Oil—Eldon N. Dunlap, in PETROLEUM TECHNOLOGY, Vol. 1 (1938), No. 1, T.P. 874, 11 pages. (See also preceding abstract—Ed).

Recently the producing branch of the petroleum industry has shown a considerable and growing interest in the quantitative determination of the water, oil, and gas content of cores as it relates to estimation of reserves, to providing a basis for judging as to the feasibility of applying various secondary-recovery and pressure-maintenance processes, and in general to the operation of producing properties. For years it has been known that oil, gas and water co-existed in the pores of many semi-depleted oil measures. It is now generally believed that oil-bearing beds contain connate water in amounts varying up to 50 percent of the pore space. Only lately has reliable evidence of the extensive occurrence of connate water in oil sands been published. Little work has been done to ascertain the effect of this water on the productivity and ultimate recovery of oil from wells. It was the intent of this research to study the influence of this indigenous water on the flow of oil through unconsolidated sands, with the hope that the results could be applied qualitatively to the flow of oil in underground reservoirs partly saturated with water.

Obviously, ultimate recovery estimates based on the void volume of the reservoir will be in error unless a conscious or unconscious correction is made for the volume of water occupying a portion of the effective pore volume of the reservoir. Although the mere fact that the connate water renders part of the pore volume of the reservoir incapable of containing oil is of primary importance to the operator, it is also of interest to know whether and to what extent the presence of varying amounts of interstitial water influences the permeability of the sand to oil.

The author made laboratory experiments which allow of the following tentative conclusions:

As the water saturation of unconsolidated sands exceeds approximately 15 percent of the pore volume, the permeability of the sands to oil probably decreases rapidly. Methods that would remove water from the sand immediately surrounding a well should prove useful in increasing the productive capacity of the well and might retard the intrusion of edge water into the well. It is possible that unconsolidated oil-bearing sands with water saturations as high as 50 percent can produce 100 percent oil with no water; this evidence supports previous ideas on the subject based on laboratory examination of cores. This conclusion emphasizes the importance of ascertaining and accounting for the water saturation of oil sands in estimating oil reserves.

Contribution to Study of Well Cuttings in Rotary Drilling—Heinrich Pilger in OEL UND KOHLE, vol. 13 (1937), No. 44, pp. 1127-1137.

Reports of American success in deciphering the geological significance of rotary drill cuttings induced the author to apply these methods to wells in the North German oilfield. The macroscopic and microscopic characters, specific gravity, heavy mineral content, calcium carbonate content and color of the streak on porcelain were determined on clayey and sandy specimens from all horizons. The speed at which hole is being made during drilling was observed every 10 minutes; this gives an idea of the relative hardness of the different horizons.

Features that are especially useful for identification purposes are calcium carbonate content, velocity of drilling and color of the streak on an unglazed porcelain plate. This latter characteristic is found to be highly significant, especially with clays, marls and sandy shales. When the streaks are closely compared very small differences may be noted. By this means most horizons and transition zones can be distinguished with considerable assurance, and many others with absolute accuracy. However, there are various sources of error such as contamination of the samples by material dislodged from the wall of the hole by the drilling instruments in going in and coming out of the well. In view of tectonic complications in the North German field it is not possible to dispense with coring; under less complicated American conditions a study of drill cuttings may suffice.

OIL WELL OPERATION

Treating Emulsions—Henry J. Cavigli, in OIL WEEKLY, vol. 88 (1938) No. 1, pp 17 - 22

Among the problems that oil operators are confronted with, none is so difficult to analyze and correct as that of extracting the water produced in many fields along with the oil and gas. Removal of this dispersed colloidal water so firmly held by the oil has proven perplexing and costly to producer, refiner, and pipe line operator.

Emulsions, unfortunately, are not all alike and require different methods of treatment in various fields. These different methods demand different quantities of anti-emulsion chemicals in those cases that necessitate chemical treatment. Since chemicals cost money it is of importance to limit their use to the optimum amount, and to avoid the too frequent case where three and four times as much treating compound is injected into the field oil than is needed.

In order that the operator may have a handy means of gauging the right amount of anti-emulsion compound to use, the author has devised a small pump outfit for feeding the compound into the oil line at any desired rate. By starting with small quantities and gradually increasing them as it is possible to note the exact rate at which the compound will produce the optimum result.

Acid Treatment of Oil Sands in South Texas—F. B. Plummer, in OIL WEEKLY, vol. 88, (1938) No. 1, pp 24 - 30

The popular conception of the acid-treatment process is that the acid is forced by pressure back into the oil-producing formation and that in passing through the capillary spaces and interstices in the rock it enlarges the pores and passageways by solution, so that more oil can flow into the well. The following is a quotation from a popular article on the subject and illustrates this conception clearly. "When a well strikes a tight non-porous pay horizon, acid will eat its way for some distances through those dense beds and possibly connect the holes with more porous beds close by."

Experimental studies on holes in Edwards limestone, Austin chalk and Pennian limestone show that the main effect of the acid treatment is to enlarge the hole. The amount of the enlargement can be calculated by knowing the amount and strength of the hydrochloric acid used and the density of the limestone in the hole. For example, a 6-in. hole treated with 300 gal. of 50 percent commercial hydrochloric acid and 50 percent water will enlarge the diameter to 2.56 ft. (a five-fold enlargement in volume of hole), which according to theory should enlarge production by 33 percent. Actual experiments showed that when the hole was enlarged 4 times the production increased 145 percent.

It sometimes happens that acid treatment increases water production in wells that are making some water. A technique has therefore been introduced of placing cement ahead of the acid and of treating only the upper or oil zone in the limestone; this practice has been quite successful. Naturally each separate well is a problem in itself and demands expert study by the geologist, the engineer and the practical and experienced operator.

Gas Lock Conditions in Pumping Wells—R. H. McLemore, in OIL WEEKLY, vol. 87 (1937), No. 12, pp. 17 - 18.

A problem that has long bothered operators in areas where the production must be obtained by pumping is the tendency of wells to gas-lock before the daily allowable has been produced. This condition is brought about by the accumulation of free gas in the casing, which lowers the fluid level below the tubing perforations and allows the gas to collect in the working barrel. The well is then in a state of equilibrium. The casing pressure plus the weight of the fluid in the casing, up to the tubing perforations, puts sufficient back pressure on the face of the sand to prevent any more oil from coming into the bore of the well, and with the tubing full of fluid, the gas cannot escape from the working barrel. The plunger, moving up and down within the barrel and compressing the gas that does not slip past the cups on each stroke, cannot lift its load of fluid on each upstroke.

Usually this condition can be prevented by releasing the casing pressure and allowing the fluid to rise in the casing and submerge the perforations. A sudden release of this pressure will often pull sand into the well, and any reduction in casing pressure beyond that which is necessary will increase the water encroachment hazard and also result in an unnecessary waste of reservoir energy. The amount of gas that will have to be produced from the casing

in order to obtain the production or allowable will vary according to the bottom pressure, the depth of the tubing perforations and the quantity of free gas that is being released by the oil within the hole. It is often necessary to release all of the gas that will escape from the casinghead open to the atmosphere in order to keep the well from gas-locking, but it is also true, often, that only a small amount of gas, bled off into the atmosphere, or into the separator, is necessary to maintain the fluid seal.

A method of hooking up the bleed-off arrangement that has proved very satisfactory in a number of places, where it is necessary to bleed only small quantities of gas, has been to connect the casing with the flow line by means of ¼-in. copper tubing, adjusting the rate of bleed-off with a small petcock. This is cheaply and easily installed and is entirely adequate in a number of fields.

NATURAL GAS

Calculation of Equilibria in Hydrocarbon Mixtures—Stuart E. Buckley, in PETROLEUM TECHNOLOGY, vol. 1 (1938), No. 1, T.P. No. 872; 11 pages.

The application of hydrocarbon equilibrium data to various problems encountered in refining and in natural gasoline recovery is an old and well established practice. Both generalized data and data on specific hydrocarbon systems have been made available by a number of investigators. More recently such data have been applied to the relations governing the separation of oil and gas both in the reservoir and at the surface. Most of the applications to production problems, have been based upon examinations of surface samples of oil and gas. This paper describes a technique that has been used satisfactorily in a number of cases to calculate the behavior of the oil and gas during the various stages of separation at the surface incident to production, directly from the data on a subsurface sample of the reservoir fluid.

The system of calculations is not designed to supplant field data, but rather to correlate with them laboratory data obtained under controlled conditions. The chief advantage of the calculations is the possibility of their use at a minimum of both time and expense to determine completely the effect of any possible operating technique upon each of the following: (1) The gas-oil ratio resulting from liberation of the dissolved gas; (2) the composition and gasoline content of the liberated gas; (3) the composition and gravity of the residual oil; (4) the amount and composition of the gas liberated upon flashing the oil from the separator to the stock tank; (5) the shrinkage of the oil in passing from the reservoir to the stock tank.

This information is frequently essential to the correct determination of the advisability of installing a natural gasoline plant, to design such a plant to take care of seasonal production, and to determine the optimum separator pressures to carry in various parts of a field.

Polymerization in Relation to Natural Gasoline Manufacture—Henry N. Wade, in OIL & GAS JOUR., vol. 36 (1937), No. 29, pp. 35 - 41.

At the present time two general types of plants are in commercial use for making gasoline from the light raw materials, propane and butane. One of these is the Unitary Thermal Polymerization process; the first plant using this process was installed at the Alamo refinery of the Phillips Petroleum Company (Borger, Tex.); this process is referred to as a straight heat-pressure-time process. The other is the Dubbs Catalytic Process licensed by Universal Oil Products; the first unit employing this process was installed in March, 1937, in the McKee gasoline plant of the Shamrock Oil & Gas Corp. in the North Texas Panhandle.

Both the straight thermal process and the catalytic process, then, use the initial heat-pressure-time step for converting the paraffin feed stock more or less completely into unsaturates. In the simple thermal process the conversion of the light unsaturates into heavy ones is accomplished along with the initial breakdown in one operation; in the catalytic process the conversion is partly accomplished by treating the fractionated products of the breakdown with a catalyst. In both processes the final step consists of fractionating out the undesired products, to yield a final liquid product of the desired boiling range. Both processes also require some recycling of materials in the thermal stage, since the reactions do not carry through to completion in a once-through process. The recycle material is derived from the fractionation following the primary conversion, and is made up of the unconverted paraffins and some of the unsaturates which are too light to retain in the final product.

A cost analysis for the Unitary thermal process is presented for a plant producing 2,100 bbl. a day, operating on refinery gas containing 22.3 percent of unsaturates. On the basis of figures available it is concluded that in a 200 bbl. plant the cost of the finished poly gasoline is about 5½ cents a gallon; in a 1,000 bbl. plant it would be about 6½ cents.

These figures are based on the use of mixtures of propane and butane. If substantially pure butane is used, as in the Dubbs process, the above cost figures will more or less apply. Considering the poly product itself for use straight as motor fuel, there are probably very few locations at the present time where a profit could be shown in competition with other methods of producing motor fuel. However, there may obviously be cases where the value of the poly product for blending purposes may be much greater than its value if used straight for motor fuel. This question must, of course, be worked out on the merits of each individual case.

In the case of the Shamrock unit, the owner company had an oil refinery which produced gasoline of low octane number, making a base blending stock which could use the peculiar properties of the poly product to greatest advantage. In spite of the fact that the value of the finished motor gasoline at the refinery was in the neighborhood of 4½ percent, the value assignable to the improvement of octane number of the finished product obtained through the use of the poly gasoline indicates a very satisfactory profit on the operation of the poly unit.

Relation of Gas-Well Spacing to Ultimate Recovery—D. T. MacRoberts, in PETROLEUM TECHNOLOGY, vol. 1 (1938), No. 1, T.P. 868; 10 pages.

This paper embodies the results of theoretical studies concerning gas reservoirs, especially the effect of drilling programs of various intensities upon pressure depletion and ultimate recoveries. The primary objective has been to determine the net quantity of recoverable gas that could be obtained as a result of each additional well, in comparison with the gas that might be secured from a single well ideally placed with respect to both acreage and geological structure. No method is yet known whereby the relative merits of intensive and sparse drilling can be compared experimentally; a reservoir must either be drilled closely or developed with wide spacing, but both programs cannot be conducted simultaneously. The analytical method seems to be the only approach to the problem.

While the present state of theoretical knowledge does not offer a precise solution to the problem of gas flow in sand bodies, it restricts any answer obtained to the realm of engineering accuracy. In solving the problem for the average gas field, it was found that practically the same answers resulted as to pressure distribution, regardless of the size of the drainage radius, even though the latter was assumed to vary from a few feet as a minimum to that of the entire reservoir as a maximum. Such limits represent extreme possibilities; therefore, the practical conditions that are associated with normal development programs, in which wells are placed in the center of tracts varying in size from 40 to 640 acres, will of necessity result in less extreme variations than those indicated in the tables accompanying this paper. Stated more concisely, the amount of gas unrecovered at abandonment (of the particular field used for illustrative purposes) will lie somewhere between 4.6 and 6 percent of the total original content, no matter how intensively the field is drilled.

From the theoretical studies referred to, an equation was derived and applied to a gas field having the following characteristics:

Depth of producing formation	4,800 ft.
Sand thickness	19 ft.
Porosity	23 percent
Area	11,060 acres
Initial formation pressure	1,950 lb. per sq. in. absolute
Initial reservoir contents	278,000,000 M cu. ft.*
Gravity of gas	0.62

*Deviation from Boyle's law not considered.

The results of the investigation warrant the conclusion that if a well were drilled on every one of the 11,060 acres the ultimate recovery would be only 2,997,000 M cu. ft. more gas (1.08 percent of original content) than would be obtained from a single well.

Trend of California's Natural Gas Industry—Lester C. Uren, before CALIFORNIA NATURAL GAS ASSOCIATION, Fall meeting, November, 1937; Oil World, Nov. 20, 1937.

On the basis of such information as is available, the author sums up the natural gas situation in California as follows:

California's natural gas reserve available for future exploitation, distributed among approximately 40 producing fields, is probably in excess of 20,000,000,000,000 cu. ft. Of these fields, the Kettleman Hills North Dome has the largest proven reserve and contains a substantial part of the visible supply for future production. Important new gas reserves have lately been found in the southern San Joaquin Valley and the delta region of the Great Central Valley. Future discoveries of additional gas supplies are probable in this same region, with the aid of geophysics. Deeper drilling in present known fields may also yield additional reserves.

During the period 1920 to 1936 inclusive, the average rate of increase in demand for natural gas has been about 30 percent, largely as a result of increasing utility demand. Wastage of gas has at times been excessive, but during the last five years has not exceeded seven percent of gross production. Growing population, expanding industries, extension of utility facilities, plentiful supply and moderate price promise continued growth in the demand for natural gas, possibly reaching 500,000,000,000 cu. ft. by 1950. At this rate of consumption, the visible gas reserves seem adequate for from 20 to 40 years. Oil producers may in future be expected to reserve a larger percentage of their gas production than at present, for their own use in stimulating oil recovery, possibly withholding large amounts of gas from the utility market for this purpose. Gradual increase in the price of gas at the wells to moderately higher levels seems probable.

REFINING

Cresol as Solvent in the Refining of Lubricating Oil by the Separator-Nobel Process—H. Suida and H. Poll, in PETROLEUM, vol. 34 (1938), No. 2, pp. 1-14.

This is the complete text of a paper presented to the Second World Petroleum Congress. The main features of the research are: a comparison of the selectivity of cresol with that of phenol and nitrobenzol. It is shown that cresol has a greater selectivity than phenol and all other selective solvents used in the petroleum industry, with the exception of nitrobenzol. As a solvent cresol is most effective when nearly saturated with water (above 11 volume percent); in this condition extraction efficiency is independent of the temperature. The characteristics of a two-stage extraction process with cresol are described in conjunction with addition of certain amounts of nitrobenzol to the cresol. This is the basis of the S.N.P.; results by this process and the equipment for carrying it out are discussed in detail.

Influence of Certain Substances on the Separation of Paraffin Wax from Oil in a Dewaxing Process—E. C. H. Kolvoort, F. R. Moser and C. G. Verver, in JOUR. INST. PETROLEUM TECHNOLOGISTS, vol. 23 (1937), No. 170, pp. 734-745.

When waxy crude oils are distilled, a point is generally reached when subsequent (higher boiling) fractions contain a type of paraffin wax of very poor crystalline character, having a bad filterability and showing a high oil retention. This point occurs at a very much lower stage in the distillation with some crudes than with others. The authors believe that the phenomenon may be explained by the occurrence of branched-chain paraffins together with those of normal type.

The counteraction of oil adsorption to such kinds of waxes by the aid of wax conditioners or dopes (pour-point depressants) is discussed and a hypothesis explaining the observed phenomena is developed.

Substances that act as wax conditioners and pour-point depressants are empirically classified:

Group i. Synthetically produced organic chemicals of more or less definite structure, including "Paraflow" (a Friedel-Crafts condensation product of naphthalene and chlorinated paraffin wax) and compounds such as octastearyl-saccharose, rufigallic acid hexastearate, etc.

Group ii. Dark-colored bodies of undefined structure, pyrogenically formed in the process of cracking a hydrocarbon or fatty oil.

Group iii. Soaps of polyvalent metals.

The substances in group i, although possibly of great interest as pour-point depressants, are, generally speaking, too costly to be considered as dewaxing dopes.

Group ii is probably the most interesting from a technical point of view. When certain hydrocarbon oils are submitted to a cracking operation, it will be found that the cracked residue may have developed the desired active properties to a marked degree.

These active substances (asphaltenes) are formed from aromatic hydrocarbons in the cracking process. Only asphaltenes thus formed are effective; the asphaltenes precipitated from an uncracked crude oil or residue are inactive. It has been found that a combination of a pyrogenic dope with aluminum stearate has a particularly high activity.

Dewaxing with Heavy Solvents—Bruno Engel in JOUR. INST. PETROLEUM TECHNOLOGISTS, vol. 23 (1937), No. 170, pp. 723-733.

With special reference to the employment of centrifugal separators in dewaxing processes, with di- and tri- chlorethylene as selective solvents, it is shown how the yield of dewaxing oil can be increased by using two- or multi-stage treatment for fractional precipitation or deoiling of wax. These processes are of special practical importance because the removal of only small quantities of wax can result in a considerable reduction in pour point. A corresponding increase in yield can also be obtained in a similar way by adding small quantities of synthetic lubricating oil obtainable in the market as pour-point reducers. The latter process which is protected by I.G. Farbenindustrie and Standard of New Jersey can be applied with advantage to centrifugal dewaxing, using the solvents mentioned above.

Whereas, the synthetic oils merely reduce the pour point of the oil to which they are added, their addition prior to dewaxing with chlorinated hydrocarbons results simultaneously in an increase in yield, the extent of which depends on the quantity of polymers present in the oil. On the other hand, when it is the question of obtaining a certain pour point, the addition of the synthetic oil permits the dewaxing to be carried out at a considerably higher temperature, and thus material saving in refrigerating costs is obtained. This effect is rather remarkable seeing that the presence of pour-point reducers when dewaxing with many other solvents generally improves either the yield or the pour point, whereas in the present case the results are improved in both these respects.

Methyl Normal-Butyl Ketone as a Dewaxing Solvent—O. S. Pokorny and R. K. Stratford, in JOUR. INST. PETROLEUM TECHNOLOGISTS, vol. 23 (1937), No. 170, pp. 746-750.

From the view-point of wax solubility, miscibility temperature with oil, filter rates and cold test-dewaxing temperature relationship, methyl *n*-butyl ketone behaves in an excellent manner. Its vapor pressure is such as to render recovery a comparatively simple matter without entailing large evaporation losses. It is stable and non-corrosive under distillation conditions; it is non-toxic, and, due to its characteristic smell, its presence can be noted long before the concentration reaches the lower explosive limit, making it a safe solvent. The cost of the solvent is reasonable, and in the price range of selective solvents already successfully employed by the industry. This solvent should find wide application for dewaxing purposes.

Improvement of Diesel Fuels by Extraction with Sulphur Dioxide—Erich Steffen and Erich Saegenbarth, in REFINER, vol. 17 (1938), No. 1, pp. 12-14.

Since the Diesel engine has come to be used for road transportation in trucks and busses, it has become apparent that the black smoke and acrid fumes given off by these engines constitute a major problem to be overcome by engine manufacturers and oil refiners.

It is recalled that a similar situation existed a few years ago in regard to the smoky qualities of kerosenes, due to their content of aromatic hydrocarbons, which can be removed by extraction with sulphur dioxide according to the well-known Edeleanu process, leaving the paraffinic hydrocarbons. The authors have made a study of the possibilities of improving Diesel fuels by a similar extraction applied to six commercial Diesel fuels of various types. The results proved that in every case fuels with Diesel-index numbers (calculated from aniline point and A.P.I. gravity) of 60 or more are obtainable from all stocks by extraction with less than 100 percent of sulphur dioxide. Using 100 percent of the extractant on paraffinic and cracked gas oils raffinates with index numbers of 72 to 77 are obtained, while more severe treatment gives index numbers around 80. These raffinates have extremely low sulphur and carbon contents. The pour-points are high, but this can be taken care of by pour-point depressants.

The matter is of interest because the United States Navy recommends for aircraft purposes a product with a Diesel index number of 60, a maximum sulphur content of 0.75 percent and a maximum carbon residue of 0.1 percent. The sulphur dioxide-refined oils easily meet these specifications and at the same time the smoke and smell are greatly reduced if not entirely removed. The temperature of extraction is 30 deg. F. and in general the refining of Diesel fuels is less expensive than the same operation applied to kerosenes.

CHEMISTRY

Polymerization of Propylene by Dilute Phosphoric Acid—L. A. Monroe and E. R. Gilliland in IND. ENG. CHEM., vol. 30 (1938), No. 1, pp. 58-63.

Propylene is polymerized catalytically by dilute phosphoric acid at temperatures above 250 deg. C. and at pressures of 150 atmos. or higher. The polymerization is stepwise. The first product is dimer; this in turn reacts with more propylene to form trimer, and the latter compound then combines with more propylene to form tetramer. Somewhat above 300 deg. C., and also at concentrations of H_3PO_4 over about 30 percent, the character of the polymer starts to change, an excess of heavier compounds forming at the expense of the yield of dimer. Below these limits, the composition of the products depends solely on the extent of the polymerization of the feed and varies from practically pure dimer initially to about 35 percent dimer at nearly complete reaction. In this range the rate of dimer formation from propylene is closely proportional to the square of the reactant concentration in the gas phase above the acid catalyst, as well as to the volume and concentration of the latter.

Hydrocarbons in Virgin Naphthas—C. O. Tongsberg, M. R. Fenske and W. J. Sweeney, in IND. ENG. CHEM., vol. 30 (1938) No. 2, pp. 166-172.

The present utilization of petroleum for chemicals is confined almost exclusively to the normally gaseous hydrocarbons and the pentanes. The higher boiling hydrocarbons are not utilized because knowledge of the hydrocarbons present in petroleum is limited, hydrocarbons from petroleum are not available for either research or production use in sufficient quantity or purity, data on the chemistry of these hydrocarbons are meager, and the products from the chemical reactions of hydrocarbons may frequently be complex.

During the past three years the Petroleum Refining Laboratory at Pennsylvania State College has fractionated, in a standardized manner, approximately 20 virgin naphthas from different fields in various parts of the world. Sixteen additional standardized fractionations comprising one cracked distillate, 11 special cuts obtained from virgin naphthas, and repeat fractionations on four of the above 20 naphthas were also made.

The relatively large volume of charge, the efficiency of the column (equivalent to 75 theoretical plates), and the high reflux ratio (40 to 1) enabled a good separation of the constituents of the naphthas to be made.

Isopentane, *n*-pentane, cyclopentane, cyclohexane, methylcyclohexane, dimethylcyclohexanes, ethylcyclohexane, a naphthene boiling at 135-136 deg. C., a naphthene at 143-146 deg. C., and a naphthene at

151-153 deg. C. are present in practically all the 20 naphthas. Considering all the naphthas as one unit, the hydrocarbon present in greatest amount is methylcyclohexane. In addition to benzene, toluene, ethylbenzene, and xylene, aromatics boiling at 153 deg., 157 deg., 163 deg., 168 deg., and 171 deg. C. are present in many naphthas.

By careful selection of the naphtha, it appears possible, using efficient fractional distillation, to prepare fractions constituting five or more percent of the over-all virgin naphtha that contain 50 or more percent of a definite hydrocarbon. These hydrocarbons may be paraffins, naphthenes, or aromatics.

Despite statements in the literature, no true constant-boiling mixture of hydrocarbons was found. It was again noted, however, that when aromatic and nonaromatic hydrocarbons were distilled together, they exhibited unusual distillation relationships. For this reason it is practical to use a third component—for example, *tert*-butyl alcohol—in the separation of *n*-hexane from small amounts of benzene (4).

A great chemical industry has been developed for hydrocarbons from coal tar. It should be possible to develop similar fields for normal paraffins, isoparaffins, cyclopentane hydrocarbons, and cyclohexane hydrocarbons from petroleum.

Testing Storage Stability and Mixibility of Diesel Fuels—M. Marde, in OEL UND KOHLE, vol. 13, (1937), No. 44, pp. 1162-1166.

It is well known that Diesel fuel oils, when sufficiently refined, have excellent storage quality in the sense that they will precipitate little or no gummy substances even after long storage. The matter becomes different when two fuel oils of different origins, themselves satisfactorily stable, are mixed; such mixtures frequently show decidedly poor stability. It is thus important to have a rapid test of the blending quality of an oil; that is, how it is likely to behave when mixed with any other oil. The author bases such a test on the fact that gummy substances are practically insoluble in an oil consisting only of straight chain paraffin hydrocarbons, such as the Kogasin II produced in the Fischer-Tropsch synthesis of oil from coal. The fuel oil under test is mixed with increasing proportions of Kogasin II and the amounts of precipitated gum in the several samples are noted. Precipitation is complete in 24 hours. This test is especially applicable to fuel oils obtained in the distillation of coal; it is hardly applicable to oils consisting only of paraffin hydrocarbons.

Chemical Constituents of Paraffin-Base Lubricating Oils—J. Mullen and E. Neyman-Platt, in JOUR. INST. PETROLEUM TECHNOLOGISTS, vol. 23 (1937), No. 169, pp. 669-678.

Naphthenic hydrocarbons are those which seem to be the chief constituents of lubricating oil fractions. Their properties depend on the number of rings present in a molecule. As has been shown by the work of Müller and Pilat, the pure naphthenic hydrocarbons derived from naphthenic acids may, owing to the presence of side-chains, have very good lubricating properties, e. g. a flat viscosity temperature curve. This observation is contrary to the general belief that the advantageous properties of oils (as expressed by the viscosity index) are due to the presence of paraffin hydrocarbons only. On the other hand, the problem whether there is a greater quantity of paraffinic hydrocarbons, or rather isoparaffinic hydrocarbons, in the lubricating oil fractions, is still an open question. So far, nobody has succeeded in isolating the liquid paraffins from lubricating oils, and as the naphthenic hydrocarbons may possess those properties which are usually attributed to paraffinic hydrocarbons, there is no evidence of the presence of the latter in lubricating oil fractions.

In order to solve this problem the authors have attempted to isolate the isoparaffinic hydrocrabons from lubricating oil fractions. Starting with a material of a paraffinic character and applying only such methods as cannot result in any destruction of molecules—i.e. using only acid treatment, selective extraction and crystallization—the isolation of isoparaffins, as well as the quantitative separation of aromatic constituents from the mixture of hydrocarbons, has proved impossible. The final products obtained, corresponding, for instance, to a formula $C_nH_{2n}+_{6}4$, consist of a mixture of aromatic, naphthenic and paraffinic hydrocarbons, which, being very similar in their physical properties, are no longer separable by means of applied methods.

From very careful analysis of the hydrogenated final product it may be seen, however, that the lubricating oils, especially the light ones, contain some branched paraffinic hydrocarbons. The low melting point—14.5 deg. C.—and the high molecular weight—480—make it probable that the mixture consists partly of isoparaffins. Their amount, however, seems to be too small to have any important influence on the physical properties of lubricating oils.

Hydrogenation of Roumanian Petroleum—C. Candea and A. Marschall, in MONITEUR PETROLE ROUMAIN, vol. 38 (1937), No. 24, pp. 1879-1884.

Small-scale experiments indicate that the destructive hydrogenation of Roumanian crude oil and its products is a function of pressure, temperature, the chemical composition of the oil, the character of the catalyst and the construction of the apparatus. The most favorable pressures in the apparatus employed in this investigation lie between 200-300 atm. and temperatures between 300-350 deg. C. using a molybdenum base catalyst consisting of 13.4 gr. of MoS_3, 3.4. gr. of MgO and 2.6 gr. of Al_2O_3.

The sulphur content of the gasoline obtained by hydrogenation diminishes as the operating pressure increases, but is greater with used than with fresh catalyst. This is due to the fact that the MoS_3 tends to become reduced to the less active MoS_2. The maximum yield of gasoline from hydrogenation of original crude, topped crude, kerosene or residues is about 50 percent in each case.

PHYSICS

Surface Tension of Gasolines—S. Valentiner, in OEL UND KOHLE, vol. 13 (1937), No. 48, pp. 1259-1260.

Using a method originated by Lenard (Ann. Phys. 74, p. 381) the author investigated the surface tensions and interface tensions (between gasoline and water) between the temperatures 20 deg. and 40 deg. C. It was found that within this temperature interval the surface tension is the greater the higher the boiling points of the gasolines; the temperature coefficient of the surface tension for all gasolines is about the same, ranging between 0.011 and 0.012; for benzole it is 0.014.

The interface tension between gasoline and water also increases with the boiling points of the gasolines, but is independent of the temperature, being the same at 20 deg. and 40 deg. C.

The surface tensions of gasolines boiling from 50 deg.—60 deg. to 120 deg.—130 deg. C. range from 17.8 to 22.7 dyn/cm, and interface tensions between 45.7-39.9 dyn/cm. The surface tension increases and the interface tension decreases with the temperature.

Determining the Constitution of Mineral Lubricating Oils—Erich Herwig Kadmer in OEL UND KOHLE, vol. 14 (1938), No. 1, pp. 1-6; No. 2, pp. 32-39.

Aside from small amounts of sulphur and oxygen, the refined mineral oils of the present consist of a mixture of hydrocarbons that include saturated and unsaturated ring and chain hydrocarbons which cannot be separated even by the most painfully conducted fractionation.

In view of the impossibility of analyzing a lubricating oil by the distillation method, for an insight into its properties it is necessary to resort to physical methods of examination. The physical properties of oils that come into consideration are:

Density.....d/20
Viscosity "pol-height" (Ubbelohde).....vph.
Viscosity slope (Ubbelohde).....m.
Viscosity index (Dean & Davis).....vi.
Aniline point.....A.P.
Average molecular weight.....M.M.G.
Refraction index.....$n^D/20$
Dispersion ($x10^5$.....nF—nC)10^5
Abbe number.

Aside from these physical constants account is sometimes taken of such chemical phenomena as oxidation, asphalt and carbon formation, and a ring analysis to disclose the percentage amounts of aromatic and naphthenic rings and paraffinic side chains.

The evaluation (or characterization) of an oil may be obtained by drawing curves of one physical property as a function of one or more of the others. The curve of viscosity pol-height/density more or less clearly shows that low density is paired with low viscosity pol-height. A closer agreement is found with density and viscosity slope. Again low density pairs with low viscosity slope. Here is where synthetic oils (Fischer-Tropsch) differ sharply from natural oils.

There is a close connection between density and aniline point, and this connection becomes especially clear when aniline point is plotted as a joint function of density and viscosity.

Much has been written against the determination of the average molecular weight of an oil. But it still has a distinct significance as an average value (for that matter, density and viscosity are also average values). The data, when plotted, show the connection between average molecular weight on the one hand and density and viscosity on the other. In this connection the author takes occasion to discredit formulae for calculating average molecular weight that have been proposed by certain American authorities.

There is a remarkable (though not mathematically exact) connection between density and refraction which is fairly independent of viscosity.

The ring analysis of Vlugter, Waterman and Van Westen is extensively criticized. By means of extensive new data it is shown that there is in fact a satisfactory connection between density and percentage content of paraffinic chains and rings, but not as between the different kinds of rings; however, it is important to be able to estimate the total content of ring compounds.

There is a clear inverse relation between density (at 20 deg.) and hydrogen content.

As regards aging characteristics and physical properties, it is a fact that the specifically lighter oils are much less subject to thickening than the heavy ones (here again the synthetic oils, which contain no cyclic compounds, are excepted). However, although it is generally a fact that asphalt

formation in artificial aging increases with the density of the oil, there is here no clear numerical relation.

The conclusion is that since the various physical constants of an oil influence and limit one another, it is possible from a knowledge of these constants to draw conclusions as to what sort of a hydrocarbon mixture it is. However, while the constants and the ring analysis of an oil may throw light on its constitution, they do not elucidate the lubricity which depends on molecular orientation in the presence of metal. It may be true that tests will show an oil to be highly paraffinic and hence resistant to aging, but there is no necessary connection between paraffinicity and lubricity.

USE OF PETROLEUM

Operation and Maintenance of Multi-Cylinder Gas Engines—H. R. Hogaboom, before AM. PETROLEUM INSTITUTE, Chicago, November, 1937.

Control of cooling-water temperatures is claimed to be a major item in maintenance—higher temperatures being recommended. Lubricating difficulties are minimized by the higher operating temperatures; oil sludging is eliminated.

Starting difficulties are carefully analyzed, with recommended procedure in locating trouble. Ignition and carburetion demand the bulk of field maintenance, and detailed procedure is outlined to minimize the cost of this work.

Exclusive of interest on investment and amortization, total operating costs will range from $0.75 to $1.50 per day per engine, the average output being in the neighborhood of 20 h.p.

An operator using in excess of 200 engines in this service, with piston displacements ranging from 200 to about 450 cu. in., reports daily operating costs of $0.97 per day per engine of the larger size, $0.92 per day for the medium, and $0.87 per day for the smaller. A third operator has, from experience, built up an average figure of seven cents per horsepower per day.

All of the above figures are for operating costs only, based upon gas at 10 cents per thousand cubic feet, lubricating oils at 60 cents per gallon, and labor at $1.00 per hour. All transportation of service men, and the cost of all parts replaced in the engine during periods extending upwards of five years, are included.

The quoted costs seems to cover the cost of maintenance and operation where competent men are employed and properly directed. If costs exceed those given, it is quite probable that money can be saved by a study of this problem of engine maintenance.

The Diesel as a High Output Engine for Aircraft—Ernest G. Whitney and Hampton H. Foster, before SOC. AUTOMOTIVE ENGINEERS, January, 1938.

Diesel engines have achieved little success as aircraft engines in the United States or any leading nation in aviation with the single and notable exception of the Junkers engine development in Germany. That the Junkers success has been so outstanding and its development and progress so unswerving in the face of the recent rapid strides made by the gasoline engine with improved cooling and better fuels, cannot fail to attract the attention of even the most skeptical concerning the merits of the Diesel engine for aviation.

The object of this paper is to analyze and present results obtained at the National Advisory Committee for Aeronautics laboratory in order to draw a clearer picture of the present state of development of the Diesel engine and to point out gains to be expected from its further development and hence its relative suitability as a power plant for all types of aircraft.

From this analysis it is concluded:

The four-stroke-cycle Diesel engine with the present technique of combustion control can, through the use of higher boost pressures and with maximum cylinder pressure not over 1,400 lb. per sq. in., provide a maximum power for take-off equal to that obtainable from present gasoline engines using 100 octane fuel to maximum power advantage.

The same Diesel engine can attain lower specific fuel consumptions than the lowest obtainable from the gasoline engine using 100 octane fuel to maximum economy advantage.

Because the anti-knock value of the fuel does not limit the performance of the Diesel engine, it offers the possibility of using very high cylinder pressures to the advantages of power and fuel economy, if engine materials and design technique are developed to use them.

The use of aftercoolers with the highly boosted Diesel engine offers substantial increases in mean effective pressures obtainable for a given specific fuel consumption.

The altitude performance of the Diesel engine will be fully equal to that of the gasoline engine, although the higher boost required of the Diesel may require more stages in the blower.

The two-stroke-cycle Diesel engine offers the possibility of greater power per unit of size and weight than a similar four-stroke-cycle Diesel engine at the expense of increased fuel consumption.

Accessory Knock Suppressors—L. B. Kimball, before SOC. AUTOMOTIVE ENGINEERS, Detroit, January 1938.

An account is given of the development of an accessory knock suppressor for automotive use of the type which meters an anti-knock fluid through a valve; the fluid used is known as "Anilol," and consists of aniline and a mixture of various alcohols and corrosion reducing inhibitors. This system has found approved use in airplane operation, both for increasing the octane number of the fuel and for deicing carburetors; it is also better suited for deicing propellers than the alcohol-glycerine mixtures currently used.

Extraction Naphthas—A. Ernest McGee, in OIL AND SOAP, vol. 14 (1937), No. 12, pp. 322-327.

The edible fat, oil and soap industries are the principal consumers of extraction naphthas. The requirements of these industries call for low boiling hydrocarbons having a minimum of extremely volatile constituents and also a minimum of heavy, high boiling components that might contaminate food products.

It may be that propane and butanes will be used in the extraction industry at some future time, as experimental results on cottonseed have shown some interesting possibilities in this connection, but so far no commercial process has been developed to use these liquefied petroleum gases as such. Pentanes, hexanes, heptanes and octanes are the principal constituents of extraction naphthas used in this country, the hexanes and heptanes being practically ideal from a vapor pressure, and an odor and taste standpoint. One can now obtain at reasonable tank-car prices a petroleum naphtha of 146 to 158 deg. F. general boiling range which is made from natural gas and which is essentially a normal hexane fraction; also, it is possible to obtain at reasonable tankcar prices a petroleum naphtha of 190 to 208 deg. F. general boiling range which is made from natural gas and which is essentially a normal heptane fraction. These naphthas are distinctly preferable to wide boiling range naphthas, this being especially true in the manufacture of edible oils and meals.

Due to their comparative instability, the aromatic, olefin and unsaturated naphthene hydrocarbons are not desirable in extraction naphthas. They tend to decompose, polymerize and otherwise react to form compounds which sooner or later are very likely to cause trouble in an extraction plant from an odor and taste standpoint. These compounds are far more likely to be present in naphthas made direct from crude oil than in those made from natural gas, this being due to the higher temperatures employed in the manufacturing process causing some cracking or decomposition even though pure paraffin or naphthene base crude oils are used. Likewise, naphthas made direct from crude oil are likely not to be as good from a sulphur and nitrogen standpoint, as well as from a greasy residue standpoint, as those made from natural gas.

The extraction plants in Europe have used naphtha of about 160 to 185 deg. F. general boiling range, the material probably being made from Roumanian, Russian or other naphthene base crude oils and probably being essentially a cyclohexanes fraction. However, as most of the producers of industrial naphthas in the United States are operating with paraffin or mixed base crudes, such a boiling range as this in this country is not as desirable as either the 146 to 158 deg. F. or 190 to 208 deg. F. There simply are no commercial quantities of paraffin hydrocarbons which have boiling points such as to give a naphtha of 160 to 185 deg. F. general boiling range. Such a boiling range of course can be made from paraffin base crudes by blending hexanes and heptanes together, but such a fraction obviously would not be as good as that of either the pure hexanes or heptanes.

Extreme Pressures in Lubrication—Thomas Charles Poulter, in OIL & GAS JOUR., vol. 36 (1937), No. 36, pp. 46, 51.

Lubrication engineers sometimes declare that what an automobile manufacturer wants for a hypoid gear is not a lubricant but an anti-welding compound; to which the former might retort that the lubrication engineer should make sure that the oil he is using as a base from which to compound an E.P. lubricant does not itself contain constituents which, when subjected to pressure, produce a part of the abrasive action which it is necessary to overcome by the addition of a so-called E.P. dope. A small quantity of suspended solids in an oil is very likely to produce a bearing failure even though these particles may be softer than the two metals being lubricated. This effect is in part a result of the solid material so completely wiping off the lubricant as to permit the two metal surfaces to actually come in contact with one another to start the failure. One very likely source of suspended particles has in general been overlooked, namely those which are liquid at normal pressures, but which separate as solids under the existing pressure. In some cases these solids may be of metallic hardness. Even the normal small amount of moisture in the oil is converted to a solid at one-third to one-fourth the pressure frequently existing under the conditions where an extreme pressure lubricant is required. The solid thus formed is known as ice VI and is very much harder than ordinary ice, and under these pressures has a melting point about as high as the normal boiling point of water. Some of the normal constituents of certain oils may go through a similar transition, producing a substance hard enough to wipe the lubricant from the metal surfaces or even produce some abrasion action itself. Another phenomena which no doubt has its effect not only upon the wear, but upon subsequent failure, is the actual

penetration of water or other compressed materials into the surface of the steel. The escape of such substances frequently causes a breakdown of the metal surface.

It is the opinion of the author that the day is not far distant when the specifications of a lubricant will be largely based upon the pressure-hardness curves for not only the mixture as a whole, but upon the individual constituents.

The proper hardness curves can be theoretically determined from the condition under which the oil is intended to operate, taking into account the hardness and curvature of the two surfaces, the rate of motion of the contact point with respect to these two surfaces, the rate of motion of one surface with respect to the other, and other conditions affecting the plastic flow of the lubricant. With these specifications available, it will be possible for the lubrication engineer to design a lubricant that will have the physical characteristics necessary for it to serve as a lubricant in the true sense of the word, and which will prevent abrasion of the two metal surfaces.

Experiments have indicated that pressures of nearly 500,000 lb. per sq. in. may occur in the hypoid gear of an automobile in normal operation.

Motor Fuel Characteristics of Butane—V. Prever, in RIV. ITAL. PETROLIO, vol. 5 (1937), No. 54, p. 13.

The Fiat Automobile Company has made experiments on the use of liquid butane contained in pressure cylinders as a motor fuel, in which it was found that at low engine speeds (2,000-1,000 r.p.m.), with a compression ratio of seven and a maximum advance of 39 deg., butane gives 4 to 6 percent less power than Esso. The chief difficulty appears to be excessive refrigeration due to expansion of the vapor as the butane leaves the pressure cylinder.

Effect of Altitude on Anti-Knock Requirements of Cars—Neil McCoull, K. L. Hollister and Roy C. Crone, before AM. PETROLEUM INSTITUTE, Chicago, November, 1937.

The anti-knock value required of gasoline by automobiles in order to suppress knock decreases with increasing altitude. For average cars, the rate of decrease varies from about three octane units per 1,000-ft. elevation from sea level, to about 7.5 units at 12,000 ft.

Over the large area of the Western Plains, where the altitude is over 4,000 ft., average cars can use gasolines of at least 10 octane units lower value than at sea level. None of the cars tested required over 63 octane at this altitude, although some required up to 78 at sea level. There are at least seven states which are several hundred miles from an altitude less than 2,000 ft., where a gasoline can be used of about 5 octane units lower value than at sea level.

The mixture ratio supplied by the carburetors of average cars becomes excessively rich at high altitudes. Use of smaller carburetor jets noticeably improves the acceleration of cars under these conditions. They also increase the anti-knock requirement of the car a few units but, even so, the requirement is far below the anti-knock value of commercial gasolines.

Appreciation of the cracked series varied from 6 octane units to a depreciation of 1.5 units—in other words, one car gave 6 octane units higher rating to the cracked gasoline than its A.S.T.M. rating, and another car gave 1.5 units lower rating to a gasoline containing about 80 per cent of a cracked stock than the A.S.T.M. method.

The rate of change of anti-knock requirement with altitude was only slightly less with the cracked than with the straight-run series, due to the depreciating effect of altitude. The anti-knock requirement obtained using the cracked series at sea level averaged 1.5 octane numbers lower than obtained with the conventional straight-run reference fuels. At 6,000 ft. the average anti-knock requirement with the cracked series was one unit higher than with the straight-run series.

The results of this test agree well with unpublished work of other organizations.

Aircraft Operations with Fuels of 100 Octane Number and Higher—S. D. Heron, before AM. PETROLEUM INSTITUTE, Chicago, November, 1937.

An attempt is made to survey the present state of knowledge of the application of 100-octane aviation fuels. Known engine effects and likely effects of 100-octane fuels on airplane performance are discussed, and the somewhat controversial matter of effect on earning capacity of commercial transport airplanes is surveyed mostly in the light of present theoretical estimates. Actual commercial operating data with 100-octane fuel are not available, and the effects on earning capacity will not become definite until such data are obtained.

Aircraft operators in general have shown a regrettable tendency to consider fuel costs in terms of price per gallon. Fuel costs are a considerable item in operating cost, and the operators' reluctance to face increased gallonage cost is understandable. Cost per pound-mile of disposable or payload is, however, the real criterion of operating expense, and this may well bear no relation to cost per gallon when considering fuels of different octane numbers.

The wide differences in engine operating conditions at take-off and cruising are not usually familiar to those outside the aircraft industry. Discussion, in rather elementary terms of these phases, as influenced by fuel octane number has, therefore, been included.

It is to be expected that, following the general use of 100-octane fuels, investigation will be concentrated on the improvements available as a result of still higher anti-knock values. Isoparaffins of higher anti-knock value than isooctane are known. One of these at least appears to be in all respects a desirable aircraft fuel, and to be not impossible of commercial synthesis.

ECONOMICS

The Motorcycle in Transport Development—Oskar Tokayer in PETROLEUM PRESS SERVICE, vol. 4 (1937), No. 48, pp. 569-571.

In 1936 there were about 3,000,000 motorcyles in the world, while the total number of motor vehicles was in excess of 40,000,000. No less than 90 percent of all motorcycles are in Europe and 1,200,000 or more than 38 percent of the total, are in Germany alone. With 56 inhabitants per unit Germany has the greatest motorcycle density in the world, and in 1936 motorcycles accounted for 55.6 percent of all German road passenger vehicles; Austria, with 67.9 percent, is the only other country in which this proportion is higher. In the United States, one of every six inhabitants possesses a motor car and only one in every 1,200 a motorcycle. The popularity of motorcycles in the above named countries is undoubtedly due in the first place to the low first cost, but chiefly to the low running and maintenance costs, as well as lighter taxation.

It is a fair inference from the foregoing that, where the Government has not imposed unreasonably high taxation on motor vehicles and motor fuels, the motor car has had no difficulty in establishing its superiority over the motorcycle. This is instanced not only by the case of the United States, but also to a large extent by that of Great Britain.

Great Britain, which in 1929 had the largest number of motorcycles, viz., 715,000, has now dropped to a position well behind Germany. During this time the number of motorcycles in Great Britain has declined by 30 percent, whereas the increase in the number of passenger cars is calculated at 70 percent. This no doubt is due to the superior attractions, for many users, of the very small type of motor car, with relatively low running costs, which has come to be produced on an increasingly large scale in Great Britain during recent years.

Separate Pipe Still and Cracking Units vs. Combination Units in Petroleum Refining—F. N. Chamberlain, in REFINER, vol. 16 (1937), No. 12, pp. 571-572.

In this prize essay by a student of chemical engineering it is shown that for a refinery processing about 8,000 bbl. a day of Mid-Continent crude the investment required by a combination straight-run and cracking system is nearly $250,000 less than that required by a plant using separate pipe still and cracking units. The combination unit uses less steam and needs a smaller working force. The manufacturing costs figure 1.152 and 1.324 respectively; the payout periods are 2.39 and 3.50 years, and of course the profits show corresponding differences in favor of the combination system.

Post-Depression World Oil Production—L. Owen, in PETROLEUM TIMES, vol. 38 (1937), No. 986, pp. 733-734.

It has been noticed that the rate of increase in world production of crude petroleum has been remarkably regular, so much so that production figures could be accurately predicted by a logarithmic formula which is written:

$$Px = P_{1880}(1.080443)x-_{1880}$$

Where P_{1880} is the production for the year 1880, and Px the production for any year between 1880 and 1932.

The great depression of 1929-32 broke up the smooth curve described by this formula, but production figures for the five-year period 1932-36 indicate that the logarithmic law of increase has been reestablished, this time on the basis of the formula.

$$Px = P_{1932}(1.08282)x-_{1932}$$

The average percent of increase per annum through the five-year period is 8,282, which closely agrees with the value of 8.0443 percent which has been calculated for the 50-year period 1880-1930.

This close agreement may be taken, in fact, to indicate that not only has the world petroleum industry recovered from the effects of the 1929-32 depression, but that it is slowly making up for the losses which it suffered during that period.

That this recovery has continued to date is proved by a comparison of the figures for the six-month periods, January to June, of 1936 and 1937. The world production of petroleum over those periods was 874,311,948 bbl. and 980,341,000 bbl. (partly estimated) respectively, which is equivalent to 12.13 percent per annum increase.

Wider Basis of Car Ownership in the United States—Oskar Tokayer, in PETROLEUM PRESS SERVICE, vol. 6 (1937), No. 46, pp. 552.

Investigations carried out by the U.S. Department of Commerce have revealed the extent to which the motor car has become an article of every-

day use in the United States, ownership having steadily increased among the lower-income classes of the population. An enquiry covering 50 cities and 250,000 motor car owners, which was recently conducted, showed that no less than 34 percent of all motor cars in circulation are in possession of owners with incomes of less than $20 a week, 55.5 percent of all cars belong to motorists with weekly incomes of less than $30 and 88.9 percent to those with incomes of less than $60. On the other hand, only two percent of all motor car owner had an income exceeding $100 a week. If these percentage figures are more or less representative of conditions throughout the whole of the United States, it means that more than 7,000,000 vehicles are used by motorists with an income of less than $20 a week.

The high proportion of small-income owners is also reflected in the large number of purchases of second-hand, as compared with new cars. In 1927, 3,497,000 cars, or 54.2 percent of the total of 6,448,000 cars taken into service, had been used before. In 1936 the proportion amounted to 62.2 percent of the total of 10,606,000 cars.

Thus, while the average ability of American motorists to pay taxes is now much less because of the millions of families having modest incomes which have joined the ranks of car-owners, the gasoline tax burden has been greatly increased and now falls chiefly on families with modest incomes. From the point of view of the effect of this on the national economy, it has been pointed out, with considerable cogency, that if gasoline taxes absorb too large a share of the earnings of the small-income car-owner, he will have less to spend on other commodities.

GENERAL

Production of German Oil, Especially in the Nienhagen Field—Oskar Deicher, in OEL UND KOHLE, vol. 13 (1937), No. 44, pp. 1083-1112.

In this extensive article the author describes production methods in Germany's principal oilfield. The article is the first complete description of the development of German production technique, which is really only about three years old. Petroleum engineers who can read German should find the article of interest in view of the claim that economical oil production in Germany is absolutely on a par with that of any other country.

Graphical Solution of Viscosity Problems of Mineral Oils—I. Groff, in MONITEUR PETROLE ROUMAIN, vol. 38 (1937), No. 20, pp. 1543-1548.

The main feature of this contribution is a large nomogram (copyrighted by The Texas Corporation) which admits of interconversion of the Barbey, Redwood, Saybolt, Engler and the centistoke viscosity scales. The arrangement is such that an immense number of problems relating to lubricating oils, especially problems relating to the delivery of a lubricant that must comply with given specifications. With the aid of this nomogram it is easily possible to determine whether the specifications can be met by blending stocks on hand.

What Type Crude Will be Found at 15,000 Ft.?—B. Mills, in OIL WEEKLY, vol. 88 (1937), No. 2, pp. 18-20.

Steady trend toward deeper oil production along the Texas-Louisiana Gulf Coast arouses speculation as to the possible lower limit to drilling in this region, and also as to what sort of oil, if any, will be found at, say, 15,000 ft. There is a prevalent opinion that the limit to deep drilling with existing mechanical equipment has been pretty nearly reached, but that 15,000 ft. depths are possibly attainable.

Refinery chemists analyzing the various Gulf Coast crudes have learned that the age of the oil affects its characteristics more than depth from which it is produced. Crude oil produced from the Frio formation at a depth of 6,000 ft. may not differ greatly from that produced from the same formation at 9,000 ft. in another field. Conversely, two widely separated formations in the same field usually produce crudes of different types. This is especially true where the two formations fall in radically different groups or ages. The composition of crude oil encountered at 10,000 ft. in one district may closely parallel that found at 12,000 ft. in another district, but it usually differs sharply if production is found at such widely separated levels in the same field.

The change in the nature of crude oil with increased depth does not worry the modern refinery. Through blending crudes and refining operations, products bordering on the synthetic will be obtained. Wax and paraffin that ordinarily increase with depth are no longer the serious problem they were 15 years ago. One major refiner even manufactured lubricating oil in commercial quantities from ordinary wax.

BOOKS

Individual Components of Petroleum Recognized To-Date, by Edmund Waldmann. Published 1937 by VERLAG FUR FACHLITERATUR, Vienna, as Publication No. 9 of the AUSTRIAN PETROLEUM INSTITUTE; 68 pages, $4.00.

This work is intended to compile in one source a list of all substances found or suspected of existing in petroleum. The first part of the book lists the hydrocarbons and organic acids, phenols, sulphur and nitrogen compounds whose presence in crude petroleum has been proven beyond a doubt. The names of these are printed in bold-faced type. Along with these are listed, in ordinary type, those chemical individuals which have been reported on more or less doubtful grounds as existing in crude oil.

The second part lists the petroleum derivatives that are known or suspected of being formed during various refining processes that have been used in the petroleum industry. No account is taken of products formed in oxidizing treatments or those contained in refinery acid sludge. Also, products formed by supplementary treatments, as hydrogenation, polymerization, etc., have been omitted. In each case are given (where known) the structural formula, the physical constants, the source of the oil and literature references. All lists are brought down to the end of 1936.

The work will prove of great use as a reference book in petroleum chemical research.

Flow of Homogenous Fluids Through Porous Media, by M. Muskat; published 1937, by MCGRAW-HILL BOOK CO., New York. 763 pages; $8.00.

Volume's title page identifies the author as chief of the physics division, Gulf Research and Development Company. When it is understood that a gentleman bearing such a title is offering a treatise on the flow of liquids through porous media, oil men will naturally infer that among the subjects discussed will be the flow of petroleum through oil sands, because that is one of the matters for the study of which organizations like the Gulf Research and Development Company employ physicists.

Inspection of the book substantiates the inference. The author takes as his province all typical problems of fluid flow that are of some practical interest, but acknowledges that in many cases they are of most concern in the oil and gas industries. Nevertheless, a considerable part of the discussion is more or less applicable to hydrological irrigation, dam construction and similar problems where fluid flow through porous media has to be taken into consideration. On the other hand, he makes no pretense of solving what is really the fundamental physical problem in most actual cases of oil production, namely, the flow of gas-oil mixtures; his task is to explain the flow of a homogenous fluid, which means either oil or gas taken separately. Even with this limitation he is able to write this large book in explaining the applications of homogenous-fluid flow to a considerable range of problems to real oil-production.

This being understood, we find the subject treated in eleven chapters, comprised in four parts. The first part gives the foundations of the subject, including an extensive discussion of Darcy's law. Part II deals with the steady-state flow of liquids and contains most of the meat of the book; here are discussed two and three dimensional flow problems, gravity flow systems, non-uniform permeability, two fluid systems, and multiple well systems; this latter chapter (IX) brings the subject immediately home to the petroleum engineer in the field. Part III treats the non-steady-state flow of liquids and part IV the flow of gases through porous media, which of course directly relates to another province of the petroleum engineer.

The book makes considerable demands on the reader's knowledge of calculus and differential equations, but for the benefit of readers who are primarily interested in results and who do not care to follow the analytical derivations, to most of the chapters the author has thoughtfully appended extended non-mathematical summaries giving the physical content of the various problems discussed, and the salient features of the theoretically de ived solutions.

Not to mention others, all oil engineers interested in well-spacing problems and flooding systems may be cited as logical purchasers and users of this excellent work, which represents years of labor by an obviously competent authority.

The Practice of Lubrication, and Engineering Treatise on the Origin, Nature and Testing of Lubricants, Their Selection, Application and Use, by T. C. Thomsen; published 1937 by MCGRAW HILL BOOK CO., New York. Third edition, 638 pages with 232 charts and diagrams, $6.00.

This third edition of Thomsen's book maintains the standard reached in the previous editions, and as usual covers practically all aspects of industrial lubrication with which engineers are likely to be concerned. The author still rightly insists that each branch of mechanical industry has its own particular problems of lubrication, hence in addition to the principles that relate to the general science of lubrication special chapters are written for the operators of steam turbines, steam engines of various types, railway rolling stocks, transmissions, machine tools, refrigerating machines, Diesel and gasoline engines, and many more. Special pains are taken to give correct methods of lubrication, but much space is also devoted to examples of faulty lubrication that have occurred, and how such troubles may be avoided.

Efficient and economical lubrication is no longer a rule-of-thumb matter; many manufacturing plants find the services of a trained lubricating engineer of great value, and the same is even more true of the engineer-salesmen of firms that manufacture and sell lubricating oils and greases. This book deserves a place on the shelf of every engineer who has active charge of moving machinery.

WORLD OIL PRODUCTION—Official Figures

All figures furnished direct to WORLD PETROLEUM by governments, except where otherwise specified—Table revised monthly

(Figures in U.S. barrels of 42 gal.—Conversion ratios used are weighted averages for individual countries)

	February 1937	March 1937	April 1937	May 1937	June 1937	July 1937	August 1937	September 1937	October 1937	November 1937	December 1937	Preliminary Figures January 1938
United States	93,173,000	106,724,000	104,979,000	110,911,000	105,812,000	110,721,000	115,090,000	109,980,000	110,911,000	104,206,000	106,579,000	106,700,000
Russia[2]	13,796,325	15,907,051	15,401,771	18,130,230	17,953,812	18,580,752	17,183,259	16,663,000[1]	17,600,000[1]	16,923,000[1]	17,600,000[1]	16,117,000
Venezuela	13,130,903	15,066,287	14,686,657	14,498,968	16,260,492	16,469,071	17,861,784	17,640,872	17,979,227	17,044,016	17,096,298	15,271,901
Iran[3]	4,847,342	6,443,516	6,329,968	6,293,460	6,752,478	7,207,398	7,313,264	7,130,570	7,074,122	7,821,616	6,637,248	6,687,000
Netherland India	4,011,266	4,415,436	4,348,185	4,553,298	4,464,725	4,708,460	4,672,953	4,586,638	4,766,689	4,626,395	4,671,582	4,483,124
Roumania	4,217,000	4,595,000	4,412,000	4,494,000	4,151,000	4,317,000	4,293,000	4,256,000	4,313,000	4,162,000	4,198,000	4,099,000
Mexico	3,922,929	4,307,952	4,249,838	3,387,950	3,338,311	3,848,587	2,800,868	3,432,101	4,372,808	4,211,293	4,349,415	4,141,000
Iraq	2,386,687	2,709,260	2,665,259	2,747,102	2,344,213	2,429,587	2,429,787	2,513,145	2,663,244	2,645,099	2,431,532	2,670,844
Colombia	1,617,441	1,622,226	1,660,469	1,678,580	1,724,173	1,681,799	1,592,592	1,617,433	1,811,759	1,797,625	1,824,956	1,748,572
Peru[4]	1,339,236	1,484,491	1,432,874	1,456,329	1,432,398	1,488,965	1,494,467	1,453,712	1,492,971	1,432,508	1,481,701	1,365,152
Argentina	1,237,459	1,394,757	1,361,540	1,381,485	1,339,940	1,355,420	1,345,513	1,369,767	1,360,000[1]	1,365,000[1]	1,370,000[1]	1,378,000
Trinidad	1,157,408	1,287,097	1,301,260	1,351,198	928,752	1,377,547	1,433,474	1,358,600	1,393,317	1,300,485	1,349,908	1,378,021
Burma[5]	601,638	635,792	625,937	690,501	638,874	633,401	679,335	701,066	660,000[1]	653,000[1]	690,000[1]	662,000
Bahrein[6]	549,260	799,994	659,557	432,748	684,348	585,917	254,937	662,861	847,988	749,354	805,236	799,000
Brunei[7]	356,897	389,612	363,226	376,191	349,500	353,313	373,760	341,111	351,711	376,487	405,623	409,592
Poland	295,620	316,844	318,360	318,360	310,780	318,360	318,360	310,780	325,940	318,360	325,940	310,000
Germany	231,466	243,012	247,060	245,088	249,434	267,847	279,727	282,155	288,926	272,665	277,551	268,028
Canada[8]	153,906	175,575	188,014	192,845	209,181	241,737	288,934	298,753	342,452	341,517	408,580	410,000
Japan[9]	194,037	207,423	198,898	206,544	200,092	204,710	214,819	205,914	210,228	214,330	211,436	217,000
Ecuador	160,787	180,727	181,352	189,658	182,696	186,175	184,780	178,122	182,053	176,252	178,776	187,525
British India[10]	155,219	167,418	162,699	172,458	181,436	168,467	168,034	159,226	200,000[1]	180,000[1]	170,000[1]	175,000
Sarawak[11]	124,609	136,887	130,481	134,523	131,625	143,445	138,031	134,311	133,684	126,439	131,901	137,497
Egypt[12]	86,780	93,432	89,480	97,077	98,021	99,182	97,818	100,699	97,203	95,082	94,509	91,927
France	39,990	43,053	41,865	42,096	45,445	42,125	43,367	44,000[1]	42,339	42,639	42,368	43,000
Austria*	18,277	20,237	19,586	21,259	20,573	21,252	17,108	16,555	17,101	18,000[1]	20,000[1]	19,000
Czechoslovakia	9,595	9,383	9,574	8,824	10,824	11,529	10,125	9,667	10,865	12,297	11,734	10,000
Others[1]	26,400	29,200	28,300	29,200	28,300	29,200	29,200	28,300	29,200	28,300	29,200	29,200
Totals	147,841,477	169,405,662	166,093,210	174,040,972	169,843,423	177,492,246	180,609,296	175,475,358	179,477,827	171,139,759	173,292,494	169,808,383

*Based on quarterly returns.

[1] Estimate. [2] Russian Sakhalin included with Russia.
[3] Anglo-Iranian Oil Company Ltd figures revised—fuel oil returned to ground has been deducted.
[4] International Petroleum Company and Lobitos Oilfields Ltd. figures combined.
[5] Does not include Assam and Punjab, which are listed separately under British India.
[6] Bahrein Petroleum Company Ltd. figures.
[7] British Malayan Petroleum Company Ltd. figures.
[8] Includes natural gasoline production.
[9] Japanese Sakhalin, Taiwan (Formosa) and Hokkaido included with Japan.
[10] Excluding Burma.
[11] Sarawak Oilfields Ltd. figures.
[12] Anglo-Egyptian Oilfields Ltd. figures.

Official Crude Oil Production Figures for 1932 to 1937

	Daily Average 1937 (Bbl.)	Daily Average 1936 (Bbl.)	Total 1937 (Bbl.)	Total 1936 (Bbl.)	Total 1935 (Bbl.)	Total 1934 (Bbl.)	Total 1933 (Bbl.)	Total 1932 (Bbl.)
United States	3,500,418	3,001,410	1,277,653,000	1,098,516,000	996,596,000	908,065,000	905,656,000	785,159,000
Russia	553,305	545,453	201,856,661	199,635,921	184,008,033	175,635,783	155,596,429	155,927,997
Venezuela	513,133	424,237	187,293,734	155,270,840	148,809,057	136,098,681	117,113,940	115,615,782
Iran*	215,727	172,080	78,740,500	62,981,377	57,522,398	57,905,242	54,443,038	49,519,393
Netherland India	148,255	131,043	54,112,933	47,961,744	45,307,913	45,107,828	41,234,498	37,988,913
Roumania	142,948	173,587	52,176,000	63,538,846	61,270,072	61,849,306	53,919,708	53,651,978
Mexico	127,275	112,098	46,455,687	41,027,915	40,240,563	38,171,946	34,000,830	32,805,496
Iraq	83,846	81,730	30,603,660	29,913,150	27,410,983	7,639,849	1,094,915	871,840
Colombia	55,609	51,246	20,297,543	18,756,110	17,597,655	17,337,900	13,136,126	16,415,214
Peru	47,833	48,068	17,459,112	17,593,149	17,056,555	16,314,381	13,257,318	9,899,265
Argentina	44,482	42,235	16,235,910	15,457,960	14,297,025	14,021,901	13,690,556	13,138,747
Trinidad	42,472	36,167	15,502,502	13,237,030	11,671,224	10,894,363	9,561,353	10,126,121
Burma	21,351	20,731	7,792,972	7,587,718	7,181,113	7,278,859	7,114,311	7,073,437
Bahrein	21,266	12,690	7,762,264	4,644,635	1,264,807	285,072	31,377	902
Brunei	12,120	9,009	4,423,612	3,296,938	3,302,905	2,705,350	2,035,656	1,200,026
Poland	10,404	10,572	3,797,580	3,869,575	3,901,881	4,011,336	4,174,079	4,219,634
Germany	8,625	8,389	3,148,300	3,076,858	2,967,438	2,204,402	1,656,602	1,594,807
Canada	7,992	4,110	2,982,572	1,504,287	1,447,204	1,410,895	1,145,333	1,044,412
Japan	6,817	6,568	2,487,841	2,403,072	2,294,878	1,872,837	1,504,412	1,683,439
Ecuador	5,922	5,308	2,161,436	1,942,467	1,731,785	1,636,619	1,619,902	1,597,641
British India	5,640	5,405	2,059,464	1,978,329	2,037,810	1,921,863	1,628,803	1,743,878
Sarawak	4,391	4,229	1,602,594	1,547,882	1,776,593	1,942,591	2,206,815	2,329,733
Egypt	3,147	3,392	1,148,801	1,241,550	1,234,170	1,501,624	1,625,895	1,854,057
France	1,387	1,562	507,067	534,063	529,664	700,000	786,366	755,146
Austria	631	143	230,185	52,339	46,312	29,246	5,992	840
Czechoslovakia	339	346	123,474	126,603	136,580	177,797	121,695	126,603
Other countries	942	826	344,000	303,300	352,500	401,000	385,500	369,800
Total	5,585,302	4,912,634	2,038,953,777	1,797,993,658	1,651,993,118	1,517,121,671	1,438,767,449	1,306,714,101

*Conversion factor revised, February, 1938

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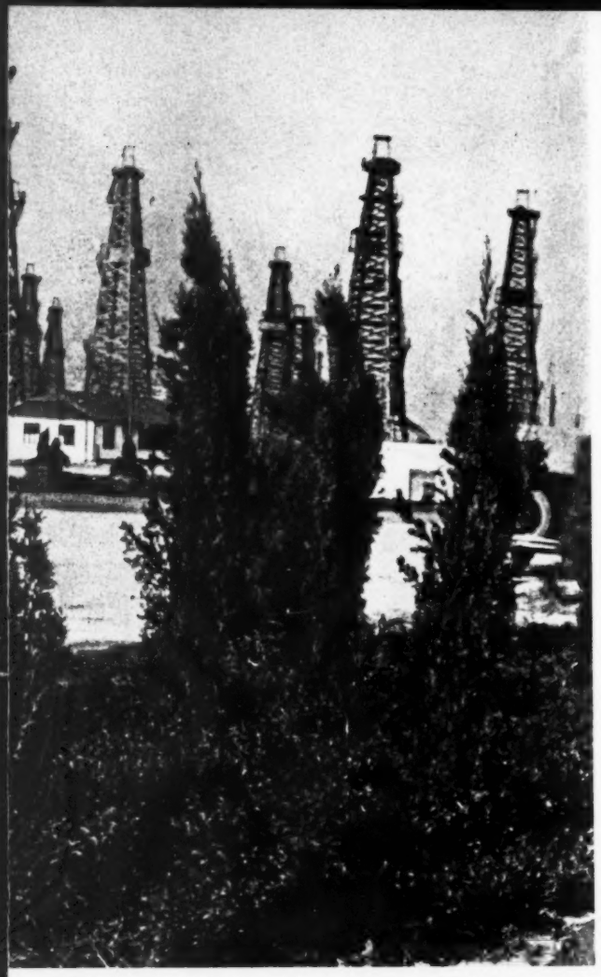

Kaganovich, with a daily output of 45,000 bbl., is distinguished for its fine arrangement of decorative greenery—shade trees and gardens have been planted on the oilfield.

GULF EXPORT PRICES FOR MAJOR OIL PRODUCTS

Products		Feb. 8	Feb. 15	Feb. 22	Mar. 1
		Cents Per Gallon			
GASOLINE:	U. S. Motor	4⅞	4⅞	4⅞	4⅞
	64/66-375 E.P.	5	5	5	5
	59 Octane and below	5⅛	5	5	5
	65 Octane and above	5¾	5½	5½	5½
AVIATION GASOLINE:	Gulf Export in cargo lots	9	9	9	9
KEROSENE:	44 w.w.	4⅞	4⅞	4⅞	4⅞
	41/43 w.w.	4¾	4¾	4¾	4¾
	41/43 p.w.	4¾	4¾	4¾	4¾
GAS OIL:	26-30 translucent	4	4	4	4
	30 plus translucent	4	4	4	4
		Dollars Per Barrel			
FUEL OIL:	Bunker C	95	95	95	95
	Cargo lots	80	80	80	80
	Diesel oil	1.90	1.90	1.90	1.90
		Cents Per Gallon			
LUBRICATING OIL:	Bright Stock No. 8	22½	23	23	23
	Bright Stock No. 6½	22	22½	22½	22½
	600 Warren E	21	20½	21	20½
	600 Unfiltered s.r.	15½	16	16	16
(New York Export Market)	650 Unfiltered s.r.	18½	18	18	18
	600 Flash s.r.	19	18½	18½	18½
	630 Flash s.r.	23	21½	21½	21½
	Neutral 200 No. 3	24½	24½	24½	24½
	Neutral 150 No. 3½	22½	22½	22½	22½
(South Texas Export Market)	Red oil 500 No. 5-6	8¾	8¾	8¾	8¾
	750	9¼	9¼	9¼	9¼
	1200	9¾	9¾	9¾	9¾
	Pale oil 500	8¾	8¾	8¾	8¾
	750	9¼	9¼	9¼	9¼
	1200	9¾	9¾	9¾	9¾
		Dollars Per Barrel			
CRUDE OIL:	East Texas delivered at Gulf for export	1.48¾	1.48¾	1.48¾	1.46

FREIGHT RATES

	Jan. 18		Jan. 25		Feb. 1		Feb. 8	
	Dirty	Clean	Dirty	Clean	Dirty	Clean	Dirty	Clean
	Shillings Per Ton							
Gulf—U.K./Continent	25/-	34/-	25/-	34/-	24/-	31/-	24/-	27/-
Aruba—U.K./Continent	22/-	28/-	22/-	28/-	22/-	28/-	22/-	28/-
North Atlantic—U.K./Continent	26/-	26/-	26/-	27/-6	18/-	27/6	18/-	27/-6

U. S. S. R.

Official Figures for Soviet Oil Operations

	Monthly Production (Bbl.)	Daily Average (Bbl.)	Run to Stills (Bbl.)	Drilling (Ft.)
Jan., 1938	17,647,000	569,258	15,882,000	520,000
Jan., 1937	16,117,461	519,918	14,412,330	443,310
Total, 1937	202,856,661	555,772	187,121,389	6,244,660
Total, 1936	199,634,921	545,450	180,582,274	6,958,916
Quota, 1938	244,215,000*	666,066	215,055,000	not available
Quota, 1937	234,450,000	642,329	208,285,000	9,240,000
Quota, 1936	222,345,000	607,000	182,250,000	7,100,000

*Crude oil and gas.

OFFICIAL statistics for Soviet oil operations during 1937 are still lacking, nor are complete details as to quotas for the Third Piatiletka yet available. Possibly the new officials in the industry are not sure as to which information may be released for publication and what divulgence would be tantamount to economic sabotage. The rest of the world must rely on incomplete details and upon informed guesses.

A. Iskanderov, successor to Barinov as head of Glavneft, has reported the usual unsatisfactory condition of the Russian oil industry during 1937 through an editorial in INDUSTRIA. Of the 800 wells drilled at Kala during the past five years 50 percent are idle, likewise 40 percent of the wells at Molotov. During the year the number of idle wells at Baku increased from 2,233 to 2,454 despite the fact that a fairly large number were found to be capable of 750 to 1,200 bbl. daily output.

The Commissar for Heavy Industries issued an order on January 21st, published January 29th, requiring a general 16 percent increase of production by all major industries during 1938. Output of crude oil and gas from all Russian fields is to be 244,215,000 bbl., of which Baku fields are to produce 178,045,000 bbl. and Grozni 22,-015,000 bbl. From sources other than this order it would appear that 10,934,000 bbl. is to come from Bashkiria, 8,750,000 bbl. from Maikop, 2,912,000 bbl. from Sakhalin, and 21,559,000 bbl. from all other fields.

Labor productivity must increase by 14 percent, while cost, which in 1937 was 8.4 percent above plan, must be reduced 3.4 percent. It is planned to bring 2,330 wells now idle into production during 1938; 2,000 at Baku, 280 at Grozni and 50 in other fields. Drilling time is to be reduced by increasing speed to an average of 1,915 ft. per table/month (2,540 ft. for production

(Continued on page 74)

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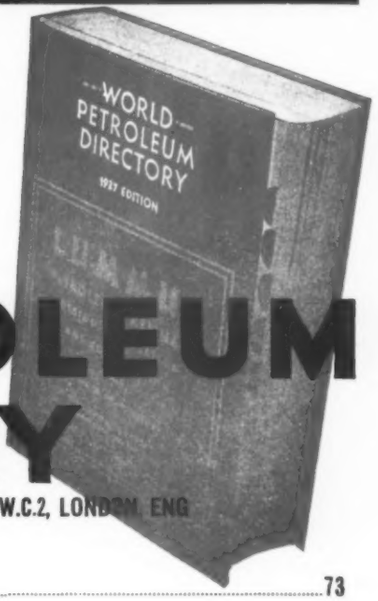

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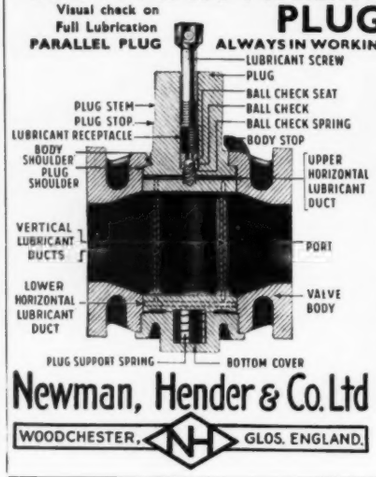

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(Continued from page 72)

and 1,207 ft. in exploration) and by reductions in breakdowns to an absolute minimum.

Wasted time during drilling activities has been excessive and an evaluation of the 40,000 hours of breakdowns at Grozni during 1937 has been officially made at Rbl. 5,000,000.

Preliminary figures for cost of drilling at Grozni are: for production, Rbl. 36.4 per ft.; (planned figure, Rbl. 33.9) for prospecting, Rbl. 66.7 per ft. (planned figure, Rbl. 59.4). Prospecting in new regions cost Rbl. 80.0 per ft. as against Rbl. 64.5 planned.

Daily plan fulfillment for the Soviet oil industry during January, 1938, varied between 92 and 94 percent. The position of the various oil trusts was better than it has been for some time—Maikop exceeded plan from 10 to 19 percent, while Baku varied between 93 and 95 percent of its quota. Grozni was 83 to 88 percent, and Emba 91 to 100 percent of planned operations. Bashkiria was erratic during the month, ranging from 52 percent of plan to 102 percent. Others varied from 73 to 85 percent of their quotas.

Prof. I. Gubkin recently remarked that his statement during the recent International Geological Congress at Moscow, had provoked criticism on the part of the capitalistic press. He had stated that Soviet reserves amounted to 46,483,200,000 bbl., of which 28,264,800,000 bbl. are proven. Said Prof. Gubkin: "They have had to admit that the figures are correct" and he went on to say that when all geological deposits of the Soviet nation are added to these proven reserves, then the U.S.S.R. ranks first with the world's oil resources. Recent research and surveys, he reported, have confirmed that his estimates were most conservative: in Azerbaidzan, Balakhani, Ramani and Sabunchi have been declared several times to be near exhaustion, but are still producing. In 1935 it was considered possible that all Baku fields with flush production might be more or less exhausted by 1938, but subsequent research has indicated that the Apsheron peninsula is still good for 145,800,000 bbl. annually for some time. New possibilities were found at Ramani, where the structure seems to fork —one branch extending to Kala and the other to Surakhani, again extending to Karachukhur and Cape Housanu.

Sikhi and San Island not only have not been exhausted, but have increased in volume of deposits as the result of further prospecting. Deep well drilling shows signs of rejuvenating Bibi Eibat while marine drilling and new regions at Busovni and Mardakhiani have added to the resources of Artema. About 35 mi. southwest of Baku, at Pirsagat, promising indications of com-

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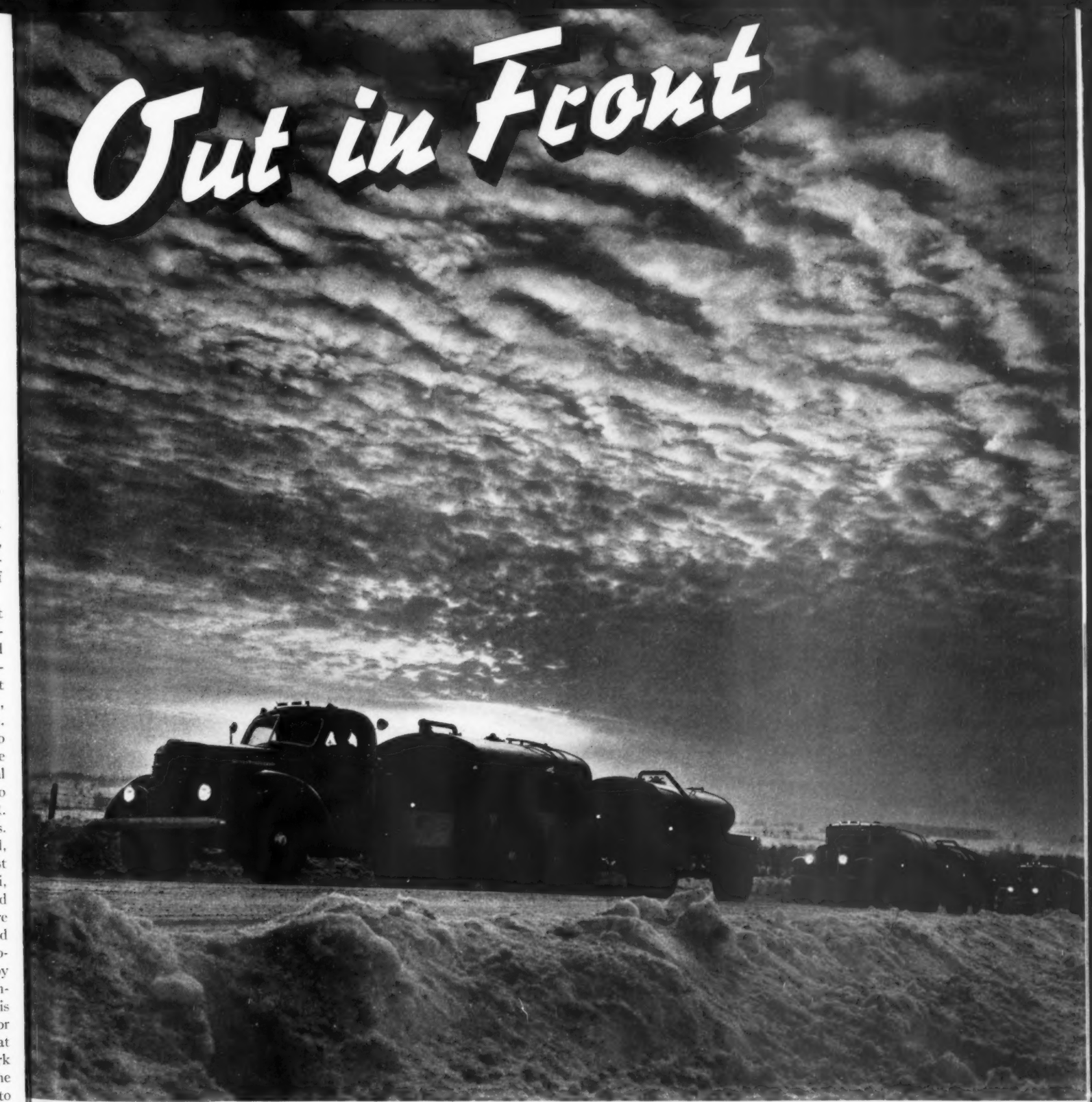

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(Continued from page 74)

mercial production exist. There should be no doubt that the Prikurinsk region and western Georgia are bound to appreciably increase the oil deposits of the Caucasus. In northern Caucasus, apart from the numerous possibilities at Grozni, the Kayakent, Achisu and Izberbash fields of Daghestan hold forth some promise, and with others near Makhatch Kala are likely to form a new group of fields in the near future.

Important extensions were made in 1937 at Asphalt Mountain, Kutais, Kuruzepe, Shiraki and Bezimeni Balki over an 18-mi. stretch which increased Maikop's output from 21,870 bbl. daily in 1936 to 36,450 bbl. in 1937.

Ishimbayevo, which produced 7,290,000 bbl. in 1937, is to be extended by a new discovery west of Uba at Tuimasi, where wells recently flowed between 700 and 1,100 bbl. daily. The Buguruslan discovery, in Orenburg region, together with Krasnokamsk, Sizran and Stavropol (Volga region) are indicative of an important oil district.

Prospecting was recently undertaken along the Viatka river between Krasnokamsk and Kirov with a view to creating a new oil base with Leningrad as its center. The Turcoman and Uzbekhistan possibilities in central Asia are well-known and the Ural Emba can easily be expanded by the territories known in western Siberia, where oil has been found along the trunk line of the Great Siberian Railway up to Kamchatka.

Soviet oil reserves, however, will be exploited only where readily accessible and the country may best be described as one of vast resources and poor development.

Exports from Russian Black Sea ports passing Istanbul during 1937, reports Julian E. Gillespie, U.S. Commercial Attache, showed a decline of 38 percent compared with 1936. Shipments were 1,552,726 tons in 1937 against 2,516,850 tons in the previous year. Consignments of gasoline, kerosene, lubricating oils and heavy fuel oils declined 31 percent, 35 percent, 34 percent and 41 percent, respectively.

Russian Black Sea Exports 1934-1937

Product	1937	1936	1935	1934
Gasoline	434,287	630,524	895,425	1,331,010
Kerosene	163,887	297,388	400,902	436,896
Lubricating Oil	212,998	327,024	245,488	254,812
Fuel Oil	741,554	1,254,730	1,617,407	1,893,492
Paraffin Wax	.....	808	1,150	8,848
Asphalt	.....	6,376	33,571	193,949
Total	1,552,726	2,516,850	3,294,943	4,129,007

The accompanying table shows the steady decline of Black Sea shipments, comprising the greater part of all Soviet exports, during the past four years. With the exception of lubricating oil in 1936 and asphalt in 1934, the falling-off has been unbroken and 1937 was only 35 percent of the 1932 total.

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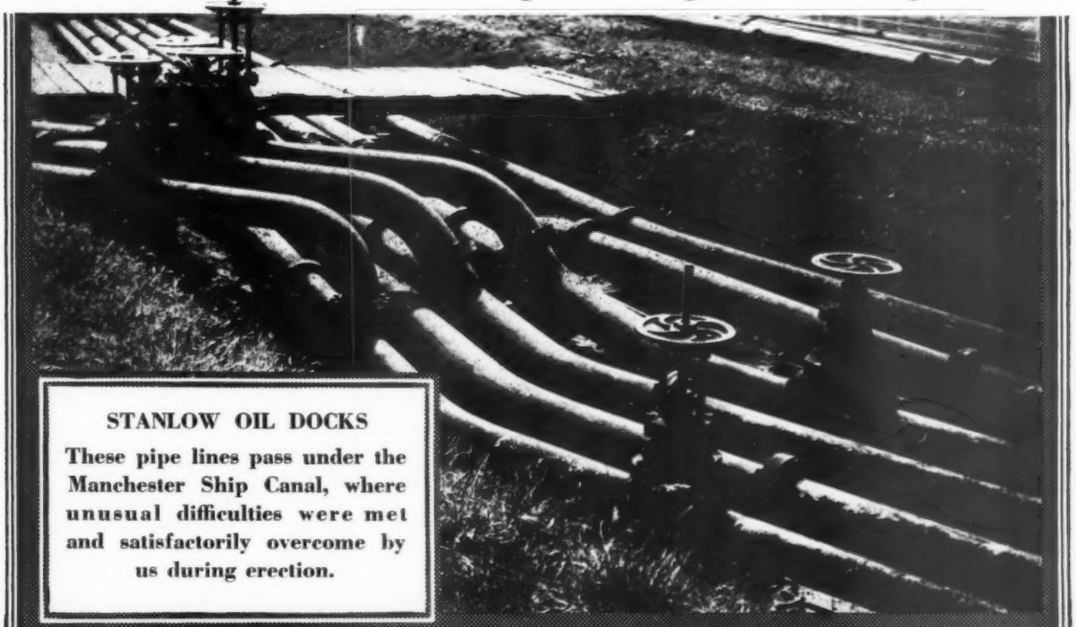

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NEW CZECH REFINERIES

DIFFERENCES which have arisen among members of the Czechoslovakian mineral oil cartel have prompted a number of applications for licenses to establish new petroleum refineries. Petitions on file are reported to come from: (1) Bratri Zikmundove A.S., V. Holan, and Jansky and Company—all wholesalers of Prague; (2) Karel Blazek, Nyrany, Bratri Fuchsove, Prague, K. Kruta, Prague, J. Opatrny, Prague, and Pragolea Company, Prague—also wholesalers; (3) Ing. Dusek and Fisr, of Kyjov, and Methan Company, of Prague—both crude oil and natural gas producers; (4) Ing. F. Hejhal of Prague—apparently new to the petroleum business; (5) Rachmiels Enzweig Erben, of Mukacevo—wholesaler; and (6) Union Mineral Oil Sales Company, of Prague—wholesaler affiliated with Creditul Minier, Roumania. Exisiting refineries, operating at half their capacity, and the refinery of the government nearing completion at Dubova, make it improbable that all six licenses will be awarded. One or two may be granted to large local concerns engaged in the trade since establishment of the republic in 1918, and whose existence is of considerable economic importance to the country.

CONGRESS FOR BERLIN

GERMANY'S substitute fuel industry will undoubtedly be one of the most interesting subjects for discussion and survey during the Third World Petroleum Congress which, it is now revealed, will be held at Berlin in 1940. This was decided at a meeting of the permanent council of the Congress in London, January 22nd. Col. Louis Pineau, president of the council, presided and representatives from Great Britain, France, Germany, Roumania, Belgium, Netherlands, and the United States were present. The council unanimously accepted the invitation of Deutsche Gesellschaft fur Mineralolforschung, presented by Prof. Dr. L. Ubbelohde, to hold the 1940 congress in Germany. While it will probably be held in May or June, the date will be made definite after consideration of the programs of other congresses to be held during the year, to avoid conflict in dates. In accepting the German invitation the council expressed its appreciation of invitations received from the United States, Austria and Holland. Prof. Ubbelohde will proceed with formation of a German committee on organization, which will work out detailed plans for the forthcoming congress, and announcements regarding these will be made periodically.

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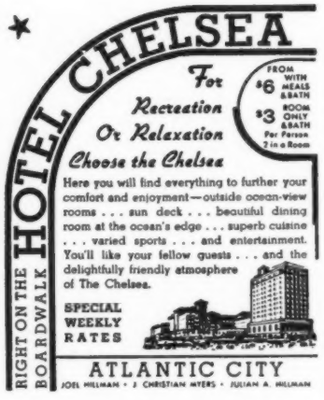
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